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DEPARTMENT OF THE ARMY FIELD MANUAL

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SIS Report 6-1

TACTICS AND TECHNIQUES OF CHEMICAL, BIOLOGICAL AND RADIOLOGICAL (CBR) WARFARE

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FIELD MANUAL

No. 3-5

HEADQUARTERS,
DEPARTMENT OF THE ARMY
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TACTICS AND TECHNIQUES OF CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) WARFARE

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CHAPTER 1

INTRODUCTION TO CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) WARFARE

1. Purpose

This manual furnishes guidance on the principles of employment of toxic chemical agents, smokes, and flame, and provides an orientation on concepts of the use of biological agents and radioactive materials by either friendly or enemy forces. The basic information furnished in this manual complements the doctrines for the employment of CBR agents presented in FM 100-1 and FM 100-5.

2. Scope

This manual describes, on an unclassified level, the tactics and techniques for the employment of toxic chemical agents, smokes, and flame, and weapons for their delivery which are now or potentially available to the field commander.

a. Chemical Warfare. Toxic chemical land mine ammunition requirements are included in appendix II. Toxic chemical ammunition expenditure tables are given in TM 3-200.

b. Smoke. Chemical smoke ammunition expenditure tables for artillery weapons and spacing guides for mechanical smoke generators and smoke pots are included in appendix III.

c. Biological and Radiological Warfare. This manual also provides an orientation on biological and radiological warfare applicable to possible employment by either enemy or friendly forces.

d. Nuclear Warfare. The material presented in this manual pertaining to chemical and biological warfare is applicable, without modification, to both nuclear and nonnuclear warfare.

3. CBR Warfare

"CBR" or "CBR Warfare" is a collective term denoting the intentional employment of toxic chemical agents, biological agents, and radioactive materials. Chemical warfare involves the tactics and techniques of the use of toxic chemical agents to produce casualties in personnel; biological warfare, the use of biological agents; and radiological warfare, the use of radioactive materials, either as prepared radioactive isotopes, or the radioactive materials resulting from nuclear explosions. These forms of warfare are not suitable for all missions and each must be utilized to take advantage of its special characteristics and effects.

4. General Policy for the Employment of Toxic Agents

Authority to initiate employment of toxic agents does not rest with the local commander. The local commander can expect to receive guidance relating to the employment of toxics through command channels. There are no restrictions on the initial employment of nontoxic agents such as flame, smoke, and defoliants. After use of toxic agents is authorized, operations involving the employment

of toxic chemical agents will normally be planned and executed by divisions and higher units subject to policy restrictions of the theater commander. Operations involving the use of toxic biological agents will normally be planned and executed by corps and higher units. The division commander may authorize subordinate units, operating separately, to employ toxic agents. Planning and conducting flame and smoke operations may be performed at all levels within a field army, but normally they will be coordinated with the next higher headquarters and adjacent units.

CHAPTER 2

RESPONSIBILITIES FOR CBR WARFARE

Section I. DEPARTMENT OF DEFENSE

5. General

The Joint Chiefs of Staff issue directives to the services of the Armed Forces prescribing policy relating to toxic chemical, biological, and radiological (CBR) warfare. Policies regarding non-toxic chemical and biological warfare are prescribed by the services independently of each other. The services are organized to conduct CBR warfare jointly or independently. However, each service employs its forces to support and supplement the other services in carrying out their missions involving the use of CBR agents whenever such participation results in increased effectiveness and contributes to the better accomplishment of the overall military objective.

6. The Army

The Army has primary interest in CBR operations on land except in operations otherwise assigned by the Joint Chiefs of Staff. The Army is responsible for investigation, development, manufacture, procurement, and supply of material pertaining to chemical, biological, and radiological warfare except those responsibilities which are specifically assigned to other agencies. The Army

furnishes chemical and biological munitions, material, equipment, and technical advice to the other services in accordance with their requirements. The Army has a special staff organization down through division level to assist in planning CBR operations.

7. The Navy

The Navy has primary interest in CBR operations on sea, in amphibious operations, and in airborne and land operations involving the employment of the Marine Corps. It may furnish CBR support to the Army in amphibious and coastal operations by means of its air arm as well as by its naval weapons. It may receive CBR logistical support from the Army and the Air Force. The Navy does not have a separate staff section to plan CBR operations.

8. The Air Force

The Air Force has primary responsibility for the aerial delivery of CBR agents against tactical and strategic land targets. Strategic operations involving the use of any of the CBR materials are under the direction of the Joint Chiefs of Staff. The Air Force may receive CBR logistical support from the Army and the Navy. The Air Force does not have a separate staff section to plan CBR operations.

Section II. BRANCHES OF THE ARMY

9. General

All units of a field army, down to and including

the battle group, have a staff organization for planning tactical operations. Operations involving the use of CBR agents are integrated into the overall tactical plan. At division and higher levels, the chemical officer advises the commander and his staff on the employment of chemical agents, biological agents, and on the radiological aspects of nuclear weapon employment. Operations involving the use of toxic agents are planned and executed by division and higher units. The planning and execution of operations involving the use of nontoxic agents may be performed at all levels within a field army. However, any operation involving the large scale use of nontoxic chemical agents, such as flame and smoke, must be planned and executed at a level commensurate with its magnitude and troop safety requirements in order to prevent undue limitations of operations of subordinate and adjacent units. At the Department of Army level, the Chemical Corps is responsible for furnishing technical advice and part of the logistical support for operations involving the use of chemical agents and biological agents. The Chemical Corps procures material for which it may *not* have storage, distribution, and issue responsibility (for example, chemical artillery ammunition). Many of the branches contribute to the conduct of CBR warfare. The capabilities and responsibilities of those branches of the Army that participate or assist in tactical operations involving the use of CBR agents are discussed in paragraphs 10 and 11.

10. Combat Arms

All arms, within the limits of the current policy

on CBR warfare, employ their normal weapons to disseminate toxic chemical agents, smokes, and incendiaries.

a. Armor. Armor is capable of employing toxic chemicals against enemy tanks and strong points; flame at enemy strong points; and smoke to blind, conceal, or signal.

b. Artillery. Artillery is capable of laying down concentrations of toxic chemical agents by means of guns, howitzers, mortars, rockets, and missiles. It is also capable of establishing smoke screens, blinding enemy observation posts, and signaling by means of smoke ammunition. By means of incendiary ammunition, artillery is capable of destroying enemy material by burning. It is also capable of firing nuclear munitions with possible accompanying radioactive contamination.

c. Corps of Engineers. The Corps of Engineers furnishes technical advice and assistance to elements of the Army in laying and clearing composite mine fields which include toxic chemical land mines, and is responsible for emplacement and detonation of atomic demolition munitions (ADM).

d. Infantry. Infantry is capable of employing toxic chemical agents, flame and incendiaries, smokes, and riot control agents. Infantry weapons capable of disseminating chemical agents are as follows: for toxic chemicals, mortars and rockets; for flame, flame throwers and flame field expedients; for smoke, mortars, rockets, and grenade launchers; and for incendiaries, grenade launch-

ers. Infantry is capable of employing biological agents against enemy personnel by means of special equipment, as available.

11. Technical Services

Within a theater of operations, the technical service organizations furnish the following services in support for CBR operations:

a. Army Medical Services. The Medical Corps furnishes chemical casualty first aid supplies to troop units. It evacuates, hospitalizes, and treats CBR casualties. It furnishes laboratory service for the examination, analysis, and identification of biological agents and of suspected biologically contaminated material. Medical personnel determine the fitness of food for human consumption following CBR attacks.

b. Chemical Services. In the theater of operations, the Chemical Corps provides CBR technical advice and supply and service support. It is also capable of furnishing chemical smoke combat support and of organizing, training, and equipping other combat support units. The Chemical services include—

- (1) Furnishing technical advice and assistance to elements of the Army on the employment of CBR agents and on defensive measures to be taken against CBR attack.
- (2) Furnishing chemical and biological munitions, supplies, and equipment to elements of the Army, Navy, and Air Force,

except those items which are specifically designated the responsibility of other technical services.

- (3) Collecting and disseminating CBR technical intelligence through G2; providing laboratory examination and analysis of CBR munitions and agents, except for biological agent analyses which are the responsibility of the Army Medical Service; furnishing technical advice on decontamination of contaminated areas and materiel, and conducting decontamination of *vital* areas and materiel contaminated with chemical agents; processing (impregnating) protective clothing and equipment; conducting field and depot maintenance of Chemical Corps materiel; and providing technical escort service for shipments of toxic chemical and biological agents.
- (4) Exercising technical supervision over radiological surveys.
- (5) Developing ways of exploiting the offensive potential of toxic chemical and biological agents by means of special equipment manned by specially trained troops.

c. Civil Affairs Military Government Services.

The Civil Affairs Military Government organization controls the civil population in an occupied country and exploits local resources in support of CBR operations. It utilizes civilian equipment and other means to assist in operation of warning systems.

d. Engineer Services. The Engineer Corps provides certain equipment which can be used for decontamination operations. Certain Engineer units are capable of performing limited area and route decontamination, and of constructing temporary and permanent protective shelters.

e. Ordnance Services. The Ordnance Corps distributes the bulk of chemical ammunition to combat elements by means of its established ammunition supply system.

f. Quartermaster Services. The Quartermaster Corps furnishes supplies for making combat shoes impervious to toxic chemicals and distributes protective clothing. It also decontaminates protective clothing and equipment in salvage channels.

g. Signal Services. The Signal Corps furnishes and maintains radiological detection devices except chemical-type dosimeters.

Section III. COMMAND RESPONSIBILITIES AND STAFF FUNCTIONS

12. General

The commander is responsible for tactical operations, including the employment of CBR agents. The commander's responsibility and the staff functions peculiar to CBR operations from the viewpoint of the staff chemical officer are discussed in this section. See FM 3-9, FM 100-5, FM 101-5, and AR 220-58 for additional information.

13. The Commander

Although the commander may accept advice and

suggestions from his staff, the commander alone is responsible for making the decision regarding any specific course of action involving the employment of CBR agents. The ground force commander determines if, when, and where CBR support for an operation will be employed. When targets are beyond or exceed ground force weapon capabilities, the ground force commander may request CBR support from the Air Force or the Navy.

14. The Staff Chemical Officer

The staff chemical officer is an adviser to the commander and his staff on matters relating to CBR warfare tactics, training, and logistics (FM 3-9). The duties of the staff chemical officer vary with the unit and the policies of the commander. During combat the staff chemical officer is concerned primarily with CBR operations and logistical support; during periods other than combat, he is primarily concerned with plans and training which pertain to CBR warfare.

15. Coordination

The field Army commander coordinates his CBR operations with those of the Air Force and the Navy in accordance with the policies and directives of the theater commander. He requests Air Force or Navy CBR support for operations when conditions require CBR agent expenditures beyond Army weapon capabilities or munition availability. He may request the other services to supply the desired support for a designated target to produce a specific effect in furtherance of his objective.

a. The Air Force. The Air Force commander determines his own requirements and capabilities in terms of aircraft, munitions, and men to deliver the CBR support requested by the Army commander. He also determines the technique of delivering the CBR agent to the target.

b. The Navy. The Navy commander determines his own requirements and capabilities in terms of ships or aircraft, munitions, and men to deliver the CBR support requested by the Army commander. He also determines the technique of delivering the CBR agent to the target.

16. Tactical Air CBR Support

The Army's requirements for tactical air CBR support are made known to the Air Force through the Tactical Army Operations Center (TAOC), the Air Support Operations Center (ASOC), and the Fire Support Coordination Center (FSCC).

a. Information To Be Furnished. Request for a tactical air CBR mission forwarded through a TAOC, ASOC, and FSCC should include the following information:

- (1) Target location.
- (2) Target description.
- (3) Results desired and type of munition or agent that can be used.
- (4) Tactical significance of the target.
- (5) Time of attack.
- (6) Target distance and direction from friendly troops.
- (7) Special control information—marking of

front lines, special means of marking the target, and special bomb line.

- (8) Other pertinent information — possible interference which the CBR attack may have with operations of friendly adjacent units.

b. Prestrike CBR Technical Coordination. Division and Corps staff chemical officers advise the G3 Air on the following:

- (1) The best chemical or biological munition, time, and method that can be employed.
- (2) The chemical or biological munitions requirements.
- (3) The availability of ground chemical or biological munitions.
- (4) The availability and requirements for chemical service troops.
- (5) Other essential technical information, to include the probable duration and stages of effectiveness of the agent-munition system recommended for use.

c. Poststrike CBR Technical Coordination. After the attack is delivered the staff chemical officer concerned notifies the chemical officer of the next higher echelon and informs him of the technical aspects of the CBR attack, to include the effectiveness of the agent-munitions system of choice.

CHAPTER 3

CHARACTERISTICS OF CHEMICAL AGENTS AND MUNITIONS

Section I. TERMINOLOGY OF CHEMICAL WARFARE

17. General

Definitions of terms pertaining to chemical warfare and used in this manual are given in paragraphs 18 through 31.

18. Chemical Casualty

A person who has been affected sufficiently by a toxic chemical agent to render him incapable of performing his functions or duties is a chemical casualty.

19. Chemical Warfare

Chemical warfare involves the tactics and techniques of conducting warfare by the use of toxic chemical agents.

20. Effects of Chemical Agents

Toxic chemical agents are employed, basically, to produce casualties among personnel. They are employed as a vapor or aerosol to produce casualties by inhalation or as a liquid to produce casualties by contact through the skin (percutaneously). Toxic chemical agents are effective by causing severe personnel losses as well as reduction in

enemy firepower resulting from the following enemy reactions: protective action for the duration of the chemical attack on the target, activities required to permit continued use of the target area, and interference with normal activity resulting from the wearing of protective equipment after the attack.

21. Dose

The amount of toxic chemical agent actually absorbed by the body is called a dose. For example, the median lethal *dose* of GB is estimated to be 1.0 mg.

22. Liquid Dosage

The amount of liquid toxic chemical agent on the skin of personnel is called the liquid dosage; it is expressed as so many grams of liquid agent on the skin. Only a portion of this dosage is absorbed by the body, the amount varying with the part of the body contaminated and other factors, specific for each agent, and the length of time a person is so exposed.

23. Median Incapacitating Dosage

The median incapacitating dosage of a toxic chemical agent is the inhaled vapor concentration of the agent multiplied by the time of exposure, or the liquid agent on the skin, which is sufficient to disable 50 percent of exposed personnel. (See par. 30 for an explanation of vapor dosage.)

24. Median Lethal Dosage

The median lethal dosage of a toxic chemical

agent employed for vapor effect is the inhaled vapor concentration of the agent multiplied by the time of exposure which is sufficient to kill 50 percent of a group of exposed personnel. (See par. 30 for an explanation of vapor dosage.) For example, the median lethal dosage of GB is estimated to be 100 mg-min/m³.

25. Percutaneous

Percutaneous means *through the skin*. Percutaneous effects may be achieved by either the agent liquid or the agent vapor penetrating the skin.

26. Persistency

Persistency refers to the length of time that a toxic chemical agent remains effective in the area of the point of release when disseminated by a particular agent-munition combination under specific meteorological conditions. It is a characteristic of the particular agent-munition combination and the specific conditions under which it is employed. It may be expressed in terms of the amount of time an unacceptable military hazard exists for unprotected troops.

27. Surprise Dosage Effect

Surprise dosage refers to the vapor return from a given expenditure of toxic chemical ammunition that is attained by the placement of the projectiles on the target area within a 30-second period. An effective concentration must be quickly achieved in the target area before troops are alerted to the toxic chemical attack and can put on their masks. Casualties can be expected from delayed masking,

leakage of some masks, defective or missing masks, and early unmasking.

28. Total Dosage Effect

Total dosage refers to the total vapor return from a given expenditure of toxic chemical ammunition that is attained over a variable period of time, depending on temperature, temperature gradient, terrain, and wind speed. In total dosage attack, the time to cover a given percentage of a target area to a specified dosage is not critical. Against troops not equipped with masks or who do not mask during the period of exposure, a given casualty effect may be achieved by total dosage attack at much less ammunition expenditures than by surprise attack.

29. Toxicity

The toxicity of chemical agents is expressed as the relative ability of the agents to produce death or incapacitation in man. For the purposes of chemical warfare, toxicity is measured by those *doses*—the amount of agent actually absorbed by the body — which will result in 50 percent of a large group of personnel becoming casualties. For example, in the case of GB, the mean incapacitating *dose* is estimated to be 0.5 mg.

30. Vapor Dosage

Vapor dosage is the amount of toxic chemical agent present in the atmosphere as a vapor or aerosol which is taken into the body either by inhalation or by absorption through the skin in a given period of time. It is usually expressed as

milligrams of agent per cubic meter of air multiplied by the time of exposure of personnel in minutes (mg-min/m^3). Since the vapor dosage is the product of two factors, concentration (mg/m^3) and time (min), the same effect can be obtained by exposure of personnel to a high concentration for a short time or to a lower concentration for a longer period of time. For example, exposure to 100 mg-min/m^3 of GB for 1 minute would produce the same effect on personnel as exposure to a concentration of 10 mg-min/m^3 of GB for 10 minutes.

31. Volatility

Volatility refers to the relative tendency of a liquid chemical agent to assume the vapor state.

Section II. CHEMICAL AGENTS

32. General

Chemical agents are tactically classified into three main groups: toxics, smokes, and flame and incendiaries. In addition, there is another group of chemical agents used for training troops in defense against chemical warfare and for riot control. The characteristics and effects of chemical agents are discussed in TM 3-215.

33. Toxics

Toxics are chemical agents which produce full physiological reactions when in contact with the skin, when inhaled, or when ingested by personnel. The toxic chemical agents currently available for tactical employment are—

a. *Nerve Gas*. Nerve gas (GB) is a quick-acting chemical agent which in liquid or vapor form produces casualties by paralyzing respiratory muscles of personnel. Inhalation of nerve gas vapors can cause casualties within minutes. Contact of the agent liquid or of high concentrations of the agent vapor with the skin also can cause casualties quickly.

b. *Blister Gas*. Blister gas or mustard (HD) is a chemical agent which in liquid or vapor form produces casualties by blistering action on the eyes, respiratory system, or the skin.

34. Smokes

Smokes consist of fine solid or liquid particles suspended in air to produce an obscuring effect. They are classified as—

a. *Screening Smoke*. The following chemical agents are used to produce screening smoke:

(1) *Fog oil*. Fog oil (SGF) is a special petroleum oil which produces a very dense white smoke when vaporized and condensed. It normally causes no adverse physiological reaction when in contact with personnel and has no adverse effect on materiel.

(2) *White phosphorus*. White phosphorus (WP) is a solid which burns when exposed to air, forming very dense white smoke. Burning particles of the agent scattered by bursting ammunition can cause personnel burns which are painful and slow to heal.

(3) *Hexachloroethane mixture.* Hexachloroethane mixture (HC) is a solid which when burning produces a grayish white smoke slightly less dense than that produced by white phosphorus. Long exposure to high concentrations of this smoke may irritate or incapacitate unprotected personnel.

(4) *Sulfur trioxide-chlorosulfonic acid solution.* This solution (FS) is a liquid which when exposed to air forms white smoke that is less dense than that formed by white phosphorus. This smoke slightly irritates the skin of personnel and is highly corrosive.

b. Signaling Smoke. Signaling smoke consists of a fuel containing an organic dye. When the fuel is burned, the dye is vaporized and then condensed to form the colored smoke.

35. Flame and Incendiaries

a. Flame. Flame fuels consist of special blends of petroleum products, usually in thickened form. Those in thickened form are viscous liquids that can be easily ignited and projected to a target. Flame produces casualties by burning and, in enclosed spaces, by additional physiological effects. Flame is used primarily against personnel, but it may also be used for battlefield illumination.

b. Incendiaries. Incendiaries consist of a combination of incendiary substances which burn with an intense heat. They are used primarily to destroy materiel.

36. Training and Riot Control Agents

Training and riot control agents are chemical agents which produce irritating or incapacitating physiological reactions when in contact with the eyes and skin or when inhaled by personnel. See FM's 19-15 and 21-48 for details of employment.

a. *Irritating Gas.* Chlorine (Cl) is a quick-acting powerful irritant of the respiratory tract. It is a true gas and is used primarily in gas chambers for training troops.

b. *Tear Gas.* *Chloroacetophenone* (CN) is a solid which when dispersed as an aerosol by burning causes eye and skin irritations and an intense flow of tears. *Chloroacetophenone* solution (CNC) is CN dissolved in chloroform. When dispersed as an aerosol, CNC produces effects similar to those produced by CN.

c. *Vomiting Gas.* *Chloroacetophenone-adamsite* mixture (CN-DM) is a solid which when burned produces an aerosol that causes flow of tears and vomiting, sneezing, and headache.

Section III. METHODS OF DISSEMINATION

37. General

The behavior and effectiveness of chemical agents vary widely with the method of dissemination. Agents may be disseminated by bursting-type ammunition, generating-type equipment and munitions, pressure-type weapons, and spray-type equipment.

38. Bursting-Type Ammunition

Bursting-type ammunition includes bombs, rockets, missiles, artillery shell, mortar shell, grenades, and land mines. When an agent-filled munition bursts on a target, the blast of the burster employed to rupture the casing disperses the agent filling. Part of the agent may be driven into the crater formed by the burst and part of it may be decomposed by the heat and force of the explosion. Depending on the size of the burster charge, shell thickness, and the physical characteristics of the agent filling, some part of the agent will be lost, but a major part of it will form a cloud of fine liquid or solid particles suspended in air. The diameter and composition of the cloud formed will vary with the type and amount of the agent filling, the strength of the burster, the thickness of the shell casing, and the type of terrain. When there are a number of bursts in the target area, clouds from adjacent bursts will merge. If there are a sufficient number of bursts under suitable conditions, a continuous cloud will be formed over the greater part of the target area. In the case of some chemical agents, this cloud may be cooler and denser than the surrounding air because of the sudden expansion of the agent filling. This results in a physical phenomenon known as "pancaking" in which the cloud merges with a smooth top surface and slowly returns to the ground, completely blanketing the entire area (fig. 1). In the case of other chemical agents, such as WP, clouds from individual bursts may pillar for 2 or 3 seconds after the burst and under some conditions form a

larger pillar. This pillar may collapse when it cools; however, it is of a very irregular pattern and is not termed a true pancake type of cloud. The particles formed by bursting-type ammunition settle to the ground, with the larger and heavier particles falling rapidly in close proximity to the burst.

39. Generating-Type Equipment and Munitions

The generating-type equipment and munitions employ heat to vaporize and disseminate agents.

a. *Mechanical Generator.* An example of this type equipment is the mechanical smoke generator which operates on the principle of vaporizing the chemical agent in hot combustion gases. The vaporized agent is then forced through outlet nozzles into the atmosphere where it cools rapidly and condenses into an aerosol of very small liquid droplets. Favorable winds must be utilized to disseminate the agent into the target area.

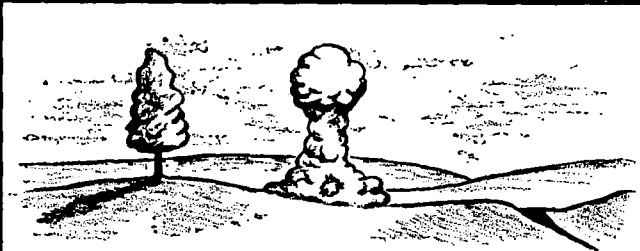
b. *Thermal Generators.* An example of this type munition is the SGF floating smoke pot which operates on the principle of using heat to vaporize the agent.

c. *Burning-Type Generators.* Examples of this type munition are the CN-DM grenade and the HC smoke pot. These munitions operate on the principle of a burning mixture, which includes the agent, burning to produce heat to vaporize the agent.

40. Pressure-Type Weapons and Munitions

The pressure-type weapons and munitions employ gases under pressure to project agents.

A PILLARING EFFECT



B PANCAKING EFFECT



C BURSTS MERGING INTO CLOUD EFFECT



Figure 1. Cloud effects of bursting-type chemical ammunition.

a. *Mechanical Pressure-Projection.* An example of this type weapon is the portable flame thrower which employs a cylinder of compressed air to project the agent toward the target. The agent is projected as a rod of flame towards the target.

b. *Field Expedient Munitions.* Examples of this type munition are the standard or improvised flame field expedients used as mines, booby traps, or fougasses.

41. Spray-Type Equipment

The spray-type equipment may be available by or through the USAF, Navy, or Marine Corps to disseminate agents. When the agent is released from the spray equipment, the liquid agent is immediately shattered into fine droplets, forming an aerosol. Because spraying distributes the liquid droplets evenly over an area, the resulting contamination, in the case of toxic chemicals, persists for a shorter length of time and produces a greater initial vapor concentration than when the agent is dispersed by bursting-type ammunition. The agent cloud formed by spray is affected by weather and terrain just as that formed by bursting-type ammunition.

Section IV. EFFECTS OF WEATHER

42. General

Weather influences chemical agents in vapor or aerosol form more than it influences those agents in liquid or solid form. The behavior and effectiveness of chemical agent vapors and aerosols are

dependent upon visibility, wind speed, temperature, humidity, and precipitation. The Air Force has the assigned responsibility to provide ground commanders with short range weather forecasts and meteorological data for specific operations. The intelligence officer of a unit obtains these weather forecasts from the Air Weather Service. The artillery meteorological system may be used within its capabilities to provide meteorological data existing at target areas. A detailed description of weather and its effects may be found in TM 3-240.

43. Air Stability

Vertical changes in temperature called vertical temperature gradients result in air stability or instability. The vertical temperature gradient given numerically in Air Weather Service micro-weather forecasts is the difference obtained by subtracting the air temperature 1 foot above the ground surface from the air temperature 6 feet above the ground surface. For the numerical values given below, the air stability conditions are—

<i>Temperature Gradient (in degrees Fahrenheit)</i>	<i>Condition</i>
Above 2-----	Inversion
2 to -2-----	Neutral
Below -2-----	Lapse

Effects of the conditions of air stability on clouds of agent (fig. 2) are as follows:

a. Inversion (Stable) Condition. An increase in air temperature with an increase in height is called an inversion condition. Such a condition usually

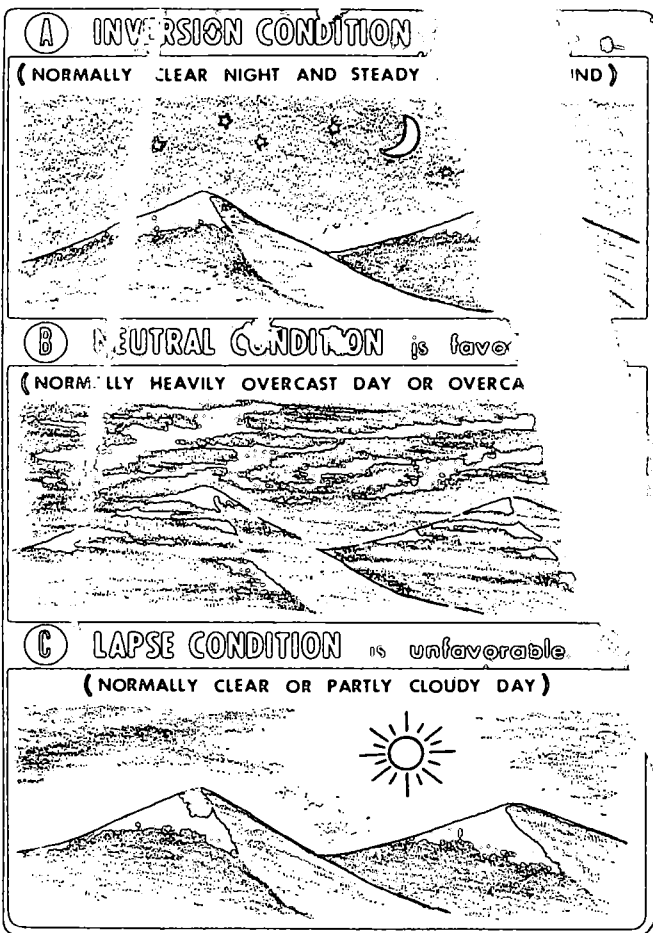


Figure 2. Conditions of air stability that affect chemical agent cloud behavior.

exists on clear or partially clear nights and early mornings until about 1 hour after sunrise. It is characterized by a minimum number of convection currents and maximum stability. Under an inversion condition with wind speeds under 5 miles per hour, clouds of agent are most persistent. With a low, but steady wind, clouds of agent can travel considerable distances without becoming too diluted to be effective.

b. Lapse (Unstable) Condition. A decrease in air temperature with an increase in height is called a lapse condition. Such a condition usually exists on a clear or partially clear day. It is characterized by turbulence from thermal currents in which clouds of agent tend to be quickly dispersed.

c. Neutral Condition. A condition between lapse and inversion is called a neutral condition. Such a condition exists when levels of air are approximately the same temperature—usually on heavily overcast days or nights and 1 or 2 hours before sunset and 1 and 2 hours after sunrise.

44. Wind Speed

When wind speed is high, clouds of agent are quickly dissipated and, in the case of some toxic agents, more munitions must be expended to insure that the agent concentration over the target area will be high enough to counteract the shortened exposure time. Liquid agent dispersed on the ground has a rate of evaporation proportional to the wind speed. Increased evaporation increases danger from vapor, but the vapor cloud, in turn, is dispersed quickly by high wind. Generally, high

winds rapidly disperse and decrease the effectiveness of clouds of agent, reducing the effective lethal coverage of and the time of exposure to the agent in the target area.

45. Temperature

The effectiveness of most chemical agents varies with temperature. High temperature increases the rate of evaporation of liquid agent on the ground, while low temperature decreases this factor. The degree to which temperature variations limit the tactical use of most agents is dependent on the physical properties of the agent, the manner in which it is dispersed, and the seasonal or climatic clothing of target personnel.

46. Humidity and Precipitation

High humidity increases the effectiveness of some toxic chemical agents, such as blister gas. Chemical agents that hydrolyze rapidly are adversely affected by high humidity. Humidity does not seriously decrease the effectiveness of most chemical agents. Heavy or lasting rains wash away most agents. Snow may cover liquid toxic agents so that little vapor hazard appears until the snow melts.

Section V. EFFECTS OF TERRAIN

47. General

The behavior and effectiveness of most chemical agents are influenced by the contour and condition of the surface of the ground and by the presence or absence of trees and vegetation (fig. 3).

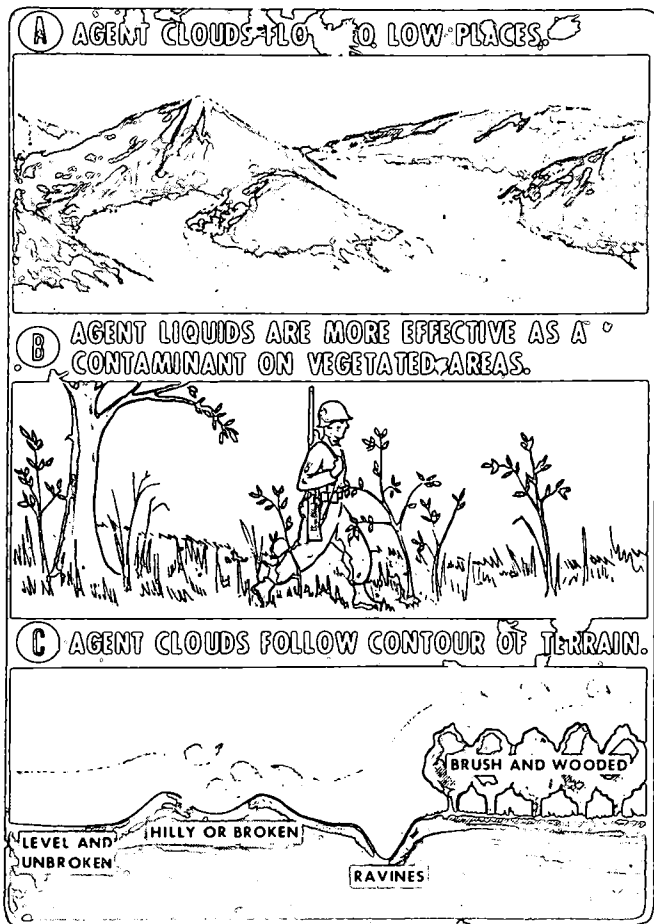


Figure 3. Effects of terrain on behavior of chemical agents.

48. Contour of Terrain

Chemical agent clouds tend to flow over rolling terrain and down valleys, to remain in hollows and on low ground and depressions, but to go around obstacles. Local winds, coming down valleys at night and up valleys in the daytime, may deflect the clouds or reverse the forecast flow; likewise, they may produce favorable conditions for cloud travel. Rough ground, including ground covered with tall grass or brush, retards the flow of the clouds; flat country or open water promotes an even, steady flow of the clouds. Under some conditions, large streams and rivers may act as obstacles to aerosols or vapor clouds moving at low wind speed across them. Obstacles, such as buildings and clumps of trees, set up eddies which tend to break up the cloud and cause it to dissipate rapidly. In areas of adjacent land and large bodies of water, daytime breezes are usually from the sea, and nighttime breezes are usually from the land.

49. Surface of Terrain

In the case of impact-detonated chemical artillery and mortar ammunition, ground texture influences agent cloud size, shell penetration, cratering, and the degree of liquid contamination. The presence of rain or snow alters surface texture; therefore, the following conditions should be considered:

a. Soft Surface. Point detonating agent-filled ammunition tends to bury into soft ground before bursting. Much of the agent cloud is, therefore, funneled up to a height sufficient to cause some

dispersion and loss of effectiveness. Also, part of the filling remains in the crater. Under unfavorable conditions, loss of agent from funneling and crater loss may be as high as 20 percent of the total filling. No appreciable loss occurs when bursting-type chemical ammunition falls on hard ground.

b. Porous Surface. If the surface on which liquid chemical agent falls is porous (such as earth, sand, brick, or tree trunk), the liquid agent quickly soaks in and some loss of effectiveness occurs. The rate of evaporation from such surfaces is, in general, only about one-third of that from nonabsorbent material. Sand is much more absorbent than grassland.

50. Trees and Vegetation

More effective agent cloud concentrations can be built up in heavily wooded or jungle areas than on open terrain. Liquid chemical contamination is generally more effective when agents are dispersed on vegetation than when they are dispersed on barren terrain. The term "heavily wooded" is used to denote jungle or forest with canopies of sufficient density to shade more than 90 percent of the ground beneath them. For purposes of chemical warfare, an area containing scattered trees or clumps of bushes is considered open terrain. In wooded areas where trees are not in leaf or where the foliage has been destroyed by previous high explosives or chemical attacks, sunlight strikes the ground and temperature gradients parallel those existing in the open.

a. *Wooded Areas.* Clouds of agent released within heavy woods tend to remain in the woods. If there are ravines and creek beds within the woods, the clouds tend to flow down them. Initial clouds of agent formed from bursting ammunition within woods in leaf and under a jungle canopy are comparatively smaller and contain higher concentrations than those formed on open terrain. Because there are usually lower wind speeds within a forest (ranging from 0 to 3 miles per hour in most cases) and more foliage, brush, and tree trunks to retard the flow of air, clouds of agent released within woods travel more slowly than they do over open terrain.

b. *Vegetated Areas.* Vegetated areas contaminated by liquid chemical agents are generally more effective against troops on foot than are contaminated open areas because the liquid agent on vegetation brushes off on clothing more easily.

CHAPTER 4

CAPABILITIES AND TECHNIQUES FOR EMPLOYMENT OF TOXIC CHEMICAL AGENTS

Section I. CAPABILITIES

51. General

Toxic agents differ in several important respects from high explosives and nuclear weapons. The capabilities and characteristics of the toxic agents must be recognized and carefully evaluated to take full advantage of them in operations. The more important properties of toxic chemical agents are described in paragraphs 52 through 56.

52. Selectivity

The commander can choose agents and weapons to produce a desired effect in a given situation. Toxic chemical agents differ among themselves and differ from high explosives and nuclear weapons in physical behavior and in effect on the target. The effects range from harassment of personnel or interdiction of an area, to lethal action. For example, mustard (HD) is effective in interfering with the use of terrain or materiel. Nerve gas (GB) or mustard (HD) can restrict the enemy use of critical installations and facilities without severe materiel destruction. These installations or facilities can then be occupied or controlled by attacking friendly forces with a minimum of time and effort expended to bring them into use.

53. Persistency

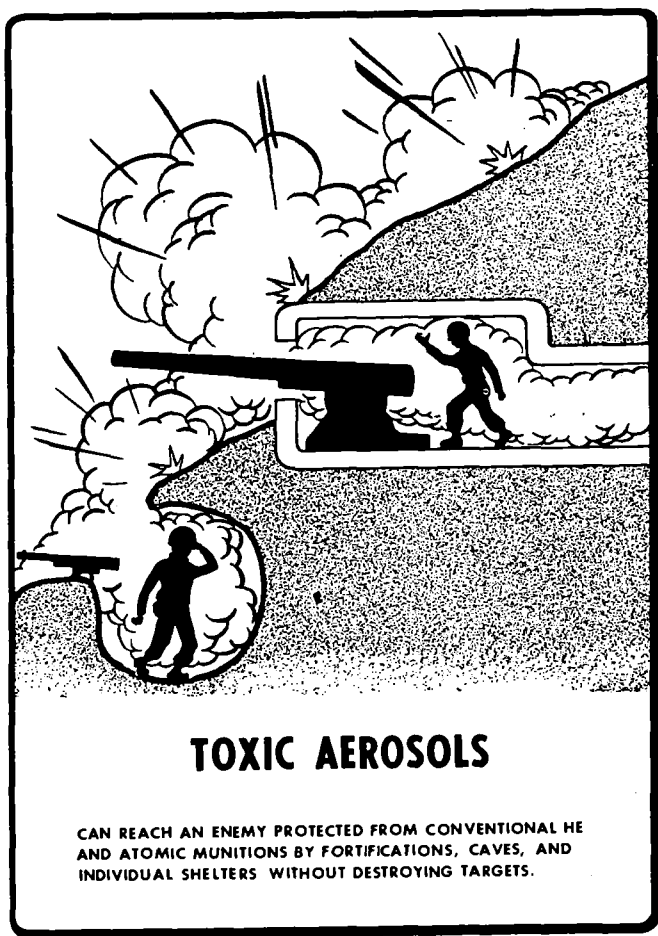
Under proper conditions toxic chemical agents remain effective in the target area for an appreciable length of time, thereby creating a continuing hazard to personnel moving into the area as well as to those already there. By a suitable selection of an agent-munition combination, the commander can vary the time an agent remains effective on the target from a few minutes or hours to a number of days. The overall objective of the operation influences the selection of the agent-munition combination to use.

54. Lessen Effectiveness of Cover

Most toxic chemical agents can be disseminated in either vapor or aerosol form. Toxic vapors or aerosols form a cloud of agent throughout the target area which can penetrate the openings of fortifications and installations (fig. 4) and envelop most battlefield obstacles. This capability of toxic chemical agents lessens the effectiveness of cover.

55. Area Coverage

Vapors or aerosols of toxic agents move with the wind. Clouds of agent can be moved varying distances from the target area by winds. Thus, the area affected extends considerable distances downwind from the target area. This downwind area may be from 5 to 25 times as large as the target area itself. This downwind capability of toxic chemical agents increases the overall agent effectiveness in terms of area coverage.



TOXIC AEROSOLS

CAN REACH AN ENEMY PROTECTED FROM CONVENTIONAL HE
AND ATOMIC MUNITIONS BY FORTIFICATIONS, CAVES, AND
INDIVIDUAL SHELTERS WITHOUT DESTROYING TARGETS.

Figure 4. Capabilities of toxic agents.

56. Fragmentation Effects

In addition to casualty effect from the agent, toxic filled munitions will produce considerable casualties in the target area from the fragmentation effects of the shell.

Section II. CHEMICAL ATTACK FOR NONPERSISTENT EFFECT

57. General

In a chemical attack for nonpersistent effect, the toxic chemical agent is disseminated in vapor or aerosol form to kill or disable personnel. The agent is delivered to the target by bursting-type ammunition, aircraft bombs or spray devices. The munitions used are designed to produce the optimum vapor or aerosol effect of the agent. The vapor or aerosol formed is effective against unprotected personnel both at the point of release and in the path of the downwind travel of gas cloud. The gas cloud may remain effective in the area of release for several minutes and, depending on weather and terrain, continue to be a casualty threat as it moves downwind.

58. Objectives

The principal objectives of a chemical attack for nonpersistent effect are to—

a. *Produce Casualties Through Surprise.* When enemy personnel are equipped with protective masks and are well trained in their use, the objective of the chemical attack is to deliver the agent directly on the target area in the shortest possible

time. Well trained troops take protective actions quickly. Therefore, a surprise concentration is required to cause inhalation of casualty dosages before enemy troops can mask.

b. Harass. The high toxicity of GB makes it a casualty threat even in low concentrations when personnel are not masked. Harassing effects are achieved by firing GB intermittently into an area to enforce masking over long periods of time. An occasional GB round interspersed in HE concentrations will cause enemy masking and alerts with every HE concentration. Continued wearing of the mask interferes with eating, drinking, and shaving. Even a moderate beard will interfere with proper fitting of the mask and cause some mask leakage. Low dosages of GB will produce marked physical and psychological effects on personnel. When harassing fires have been used over a period of time, the enemy is alert and less vulnerable to surprise attacks.

c. Produce Casualties Through Poor Gas Discipline. In any chemical attack, some personnel will be exposed to the agent through failure to put on the protective mask rapidly, through damaged or improperly worn masks, and through failure of the warning system to alert all personnel in the impact area and in downwind path of the gas cloud. Sleeping personnel, and isolated groups and individuals, such as those in working and reconnaissance parties and in traffic control posts, are particularly vulnerable.

d. Produce Casualties Among Unprotected Per-

sonnel. In a general war when toxic chemical agents are used extensively, enemy troops will normally be equipped with masks. When intelligence indicates a lack of protective equipment, casualty effect can easily be achieved by exposure to low concentrations of toxic chemicals over long periods of time. High concentrations of toxic chemicals delivered in a short period of time are not required in this situation.

e. Produce Casualties Through the Cumulative Effect. Complete physiological recovery from effects of nerve gas requires several months. Exposure to GB lowers the body cholinesterase level. Repeated exposures to even very low dosages over a period of days or weeks will gradually lower the cholinesterase level until the individual becomes a casualty. Each nerve gas exposure thus makes the individual more vulnerable to successive attacks. GB ammunition expenditures are based on casualty dosage levels required for fresh personnel, not previously exposed to GB, because intelligence on the past exposure of enemy units will probably not be available. These ammunition expenditures will result in a higher overall level of casualties among enemy units previously exposed than among fresh units.

59. Techniques of Employment

GB ammunition expenditures and techniques of delivery for a chemical attack for nonpersistent effect are based on achieving either surprise dosage effects or total dosage effects. Surprise dosages are required for casualty effect against

alert, well trained troops equipped with protective masks. Total dosages are effective when used against unprotected personnel. Total dosage attacks are effective when used as a part of a planned attrition program, over a period of several days or weeks, to cause casualties through poor gas discipline or percutaneous effect and the cumulative effects of repeated exposure. Surprise dosage attacks require on-target impact with downwind effects considered as a bonus. Total dosage attacks are effective against personnel in the impact area and in the area covered by downwind cloud travel. See TM 3-200 for GB ammunition expenditure tables.

a. Surprise Dosage Attack. Artillery, mortars, and rockets fire GB concentrations either as TOT concentrations or in battalion or battery volleys. Chemical shell thus impact nearly simultaneously or within a maximum of 30 seconds. The slow rate of fire and small area coverage of conventional artillery require the massing of fires of many artillery units of different calibers to cover appreciable target areas. Careful fire planning and timing of GB artillery fires are required for maximum surprise effect. GB fires should initiate the artillery preparation. If GB is fired at times other than at the start of the artillery preparation, target personnel may be alerted to the imminence of the attack by the initiation of preparatory fires and may be found masked or alerted to put on masks. Firing GB at the very start of the artillery preparation has the advantage of providing maximum time for dissipation of GB from the impact areas,

thus minimizing hazards to friendly troops attacking through the area.

b. Total Dosage Attack. Rapid delivery of toxic chemical agents on the target is desirable but not always necessary. Chemical ammunition impacts can be planned either on-target or off-target with reliance on downwind cloud travel to obtain target area coverage. Maximum casualty effect is achieved by on-target impact with downwind cloud travel used for casualty effect on other targets in the path of the cloud. Total dosage attacks are most effective at night for the following reasons:

- (1) Inversion conditions generally exist at night and cause maximum downwind cloud travel.
- (2) Enemy personnel are asleep or less alert and are thus more apt to be exposed to the agent.
- (3) Sleeping personnel in a dispersed position are difficult to arouse and many may be missed entirely.

Section III. CHEMICAL ATTACK FOR PERSISTENT EFFECT

60. General

In a chemical attack for persistent effect, the toxic chemical agent is disseminated in liquid form to produce casualties or to restrict the use of terrain, equipment, and materiel through the threat of casualties. The toxic agent is delivered to the target by bursting-type ammunition and by chemical land mines. Mustard munitions are designed to give maximum return of agent in liquid form

for terrain contamination. Vapor is also produced during the use of munitions and by evaporation of the liquid. Casualties result from the exposure of personnel to either the vapor or the liquid agent. Mustard is effective both as a liquid and as a vapor because the liquid mustard produces a continuous effect as it evaporates. Mustard produces a delayed casualty effect which must be considered in planning the use of this agent.

61. Objectives

The principal objectives of a chemical attack for persistent effect are:

a. *Hamper and Restrict the Use of Terrain and Material.* The presence of a contaminated area poses two alternative problems to the enemy: to avoid the contaminated area or to cross the contaminated area and incur casualties. Traversal of a contaminated area normally slows down the rate of advance of the enemy, thus increasing his vulnerability to artillery fires. In addition, the problem of decontaminating his equipment imposes a logistical and time consuming burden on the enemy. Casualty effects of liquid contamination are reduced by protective clothing, but complete protection is not provided.

b. *Produce Casualties Through Liquid or Vapor Effect.* Mustard produces casualties primarily through skin contact by either liquid or vapor. Casualties can be produced among masked personnel not wearing protective clothing. Liquid contamination is most effective in vegetated areas

since moving through the area pick up must be washing against the vegetation. Mustard whether from bursting munitions or even as a liquid, is effective against eyes, but not skin surfaces. The distinctive odor of mustard and the effect on the eyes are easily detected so that target personnel may be expected to take cover before a lethal dosage can be received. Effects resulting from exposure of skin surfaces to mustard vapor are best obtained under hot humid conditions when skin surfaces are moist. Protective clothing provides almost complete protection against normal vapor concentrations (TM 3-290). Protection for vapor effect is therefore effective only for personnel not equipped with protective clothing. Liquid mustard can produce casualties among masked personnel wearing protective clothing by its ability to penetrate impregnated clothing.

c. Increase the Effectiveness of Mine Fields and Demolitions. Liquid contamination in mine fields and demolitions increases the effectiveness of the obstacle by complicating clearing and breaching operations in minefields and delaying repairs of demolitions. Enemy personnel must wear protective clothing or run the risk of becoming casualties.

62. Techniques of Employment

HD ammunition expenditure tables provide for both liquid contamination and vapor effect. Liquid contamination is used primarily to restrict the use of terrain and materiel, such as avenues of approach, occupied or unoccupied defensive posi-

tions, reserve positions, mine fields and demolitions, and stocks of equipment. In denial operations, HD may be used on unoccupied terrain in an attempt to deny that terrain to the enemy. Mustard for vapor effect is used only on occupied targets where delayed casualties are acceptable and friendly forces do not intend to enter the area immediately. Mustard is delivered to enemy targets by ground weapons such as mortars, guns, howitzers, and rockets. Ammunition impacts should be distributed as evenly as possible over the target area. Firing units shoot HD into the area as rapidly as possible until the desired concentration is achieved. Time, however, is not a critical factor, and fire missions of 5 to 15 minutes or more are acceptable. To maintain the effectiveness of liquid contamination, periodic replenishment is usually required. See TM 3-200 for HD ammunition expenditure tables for liquid contamination and vapor effect.

Section IV. FIRE PLANNING

63. General

The general plan for the employment of toxic chemicals in support of an operation is integrated with the unit scheme of maneuver and other supporting fires. This process is similar to the integration of nuclear fire support. Once a general operational plan is approved, the Fire Support Coordination Center (FSCC) develops a detailed fire support plan which becomes an annex to the operations order. Chemical fires are not normally

published separately—they are integrated in the fire support plan along with other fires. See TM 3-200 and FM 6-20 for examples of fire planning. For most effective results when firing chemical ammunition, artillery techniques should follow the procedures discussed in paragraphs 59 and 62. Alternate plans are made to provide for unfavorable meteorological conditions and changes in the tactical situation.

64. Target Analysis

Although toxic chemical agents are area weapons, the capabilities of available delivery means and munitions limit target coverage capabilities. Toxic chemicals are not appropriate for all targets under all conditions, even if far greater delivery capabilities than those that exist were available. When properly used on selected targets, and combined with other fires, toxic chemicals offer a real contribution to tactical operations by providing weapons effects more suitable to the target than are available with other weapons. The selection of the target, the chemical agent, and the weapons to be used are determined by target analysis. See TM 3-200 for detailed target analysis procedures. The elements of a target analysis are as follows:

a. Mission. The purpose of the chemical attack is the paramount consideration. The commander may specify targets to be attacked and the effect desired on the target. More frequently, it will be necessary to make a rapid estimate of the situation to determine the most critical targets and the agent effect suited to the target. Chemical attacks are

prearranged and made against personnel primarily.

b. Target Characteristics. Of primary importance are the size and shape of the target, its location, approximate number and type of troops, degree of protection afforded by fortifications and shelters, type of terrain in the target area (particularly vegetation), predicted weather, chemical protective equipment, and doctrine of opposing troops.

c. Analysis. The unit capabilities for the attack of targets based on weapons and chemical munitions available must be developed.

d. Evaluation. Specific targets and effects on the target by available chemical agents are evaluated. The best method of employing the agent (GB surprise or total dosage attack; HD vapor or liquid effect attack) is determined along with the optimum timing of the chemical attack.

e. Recommendations. All elements required for decision by the G3 or commander are listed as follows:

- (1) Location and type of targets recommended.
- (2) Toxic agent and effect desired.
- (3) Fire support required.
- (4) Time of attack.
- (5) Limitations on total time for completion of delivery of agent.
- (6) Troop safety measures.
- (7) Coordination required with adjacent or higher units.

Section V. TROOP SAFETY

65. General

The use of toxic chemicals creates certain hazards to friendly troops which must be considered by the commander. These hazards are, generally, those created downwind of the target area and within the target area through which friendly troops must pass. There are other hazards to friendly troops caused by inaccuracies of the delivery means, but these are caused by technical matters over which the staff chemical officer has no control and are therefore not discussed in this chapter.

66. Persistency Hazard

Personnel in an area contaminated with toxic chemicals are exposed to a hazard which varies in time according to the amount and type of agent disseminated and existing meteorological conditions. Casualties will result if troops enter such a contaminated area unless they wear protective clothing, the area has been decontaminated, or sufficient time has elapsed to permit weathering of the contamination.

67. Downwind Hazard

Clouds of toxic chemicals travel downwind. If weather and terrain conditions are favorable, these gas clouds may retain a potential casualty effect for several miles downwind from the point of release. Tactical considerations may require the commander to employ toxic chemicals upwind of

friendly troops. Under such considerations, friendly troops must be warned to take adequate protective measures prior to the chemical attack.

68. Protective Measures

When toxic chemicals are employed against the enemy, the commander should require that appropriate protective measures be taken to insure the safety of friendly troops. Key personnel down to company level must be notified in time to permit essential planning and checking of protective equipment. Chemical detection devices should be checked to insure that they function properly and that trained operators are available. Individual protective masks should be checked for eyepiece or canister damage and for fit. The tactical situation permitting, the commander can require friendly troops to observe safe time intervals before entering contaminated areas or to remain safe distances downwind of the target area.

69. Traversing Contaminated Terrain

When a friendly unit is given the mission of traversing a contaminated area, the commander decides whether or not lanes will be made safe through the area. Large-scale decontamination of contaminated areas in the vicinity of the main battle positions is not feasible. Relatively safe lanes can be made quickly through mustard contaminated areas. When time and the tactical situation permit, safe lanes may be made through a contaminated area, but the nature of the work involved may alert the enemy and cause friendly

forces to lose the advantage of surprise. When the importance of the mission assigned a unit is sufficiently great and conditions do not permit making safe lanes, commanders may be required to accept the hazard and direct their troops to traverse the contaminated area.

a. Commander's Decision. A commander may accept delayed casualties and direct his troops to traverse an area contaminated with a delayed-acting toxic chemical agent, such as mustard, without protective clothing if the tactical situation so demands. The factors which will determine the number and severity of the casualties that may be suffered by troops crossing the contaminated area are: the nature and concentration of the contaminant, the presence of vegetation and the type of terrain, the meteorological conditions, the depth and width of the contaminated area, the speed with which the contaminated area can be crossed, the type of clothing worn by troops, and the personal decontamination measures taken by troops after they cross the contaminated area.

b. Precautions. When troops are directed to traverse terrain contaminated with a quick-acting toxic chemical agent, such as nerve gas, commanders should be cautioned to take suitable precautions against the danger of nerve gas desorption, especially from contaminated protective clothing. Precautions may include keeping troops dispersed and out of inclosed spaces for at least 1 hour after exit from the contaminated area and decontamination of contaminated clothing and equipment.

70. Safe Distance Data

Toxic chemicals present a vapor hazard to personnel for a predictable distance downwind of a contaminated area. An increase in the amount of agent disseminated per hectare increases the downwind distance that the vapor hazard exists from the contaminated area. Determination of the danger area from nerve gas or mustard vapors must be calculated and plotted on the situation map or operations overlay to be meaningful. The downwind danger area data must be furnished to troop units likely to be exposed.

a. GB. See TM 3-200 for estimation of downwind hazard from GB vapor.

b. HD. Refer to table I for data on downwind vapor hazard from mustard. Refined data, based on current proving ground tests will appear in a change to TM 3-200.

Table I. Downwind Vapor Hazard From Mustard (HD)

Terrain	Downwind dimension of target area (in meters) ¹	Distance downwind of HD- or H-contaminated area that vapor hazard may exist (in meters) ²		Weather condition
		Neutral conditions ³	Inversion conditions ³	
OPEN GRASSLAND.	200	900	960	HOT HUMID WEATHER ABOVE 80° F.
	500	2,200	2,400	
	1,000	4,300	4,600	
BARREN SOIL OR SAND.	200	1,100	1,200	
	500	2,700	2,800	
	1,000	5,300	5,600	
OPEN GRASSLAND.	200	1,600	1,800	WEATHER WARM 60° TO 80° F.
	500	4,100	4,400	
	1,000	8,000	8,800	
BARREN SOIL OR SAND.	200	2,100	2,300	
	500	5,200	5,600	
	1,000	10,000	11,000	
OPEN GRASSLAND.	200	2,100	2,200	COOL WEATHER 40° TO 60° F.
	500	5,200	5,400	
	1,000	10,000	10,500	
BARREN SOIL OR SAND.	200	2,700	3,100	
	500	6,500	7,500	
	1,000	13,000	14,500	

See footnotes on p. 54.

¹ These distances apply only over relatively flat terrain, unobstructed by any breaks due to presence of trees, houses, or abrupt changes of contour of the land.

² Distances are based on dosages used in ammunition requirement tables.

³ See paragraph 43 for an explanation of temperature gradients. Lapse conditions are not included in this table because the instability of the atmosphere under these conditions tends to diffuse and dissipate the gas cloud before it has a chance to travel any considerable distance downwind of the target area.

71. Safe Time Data

Toxic chemicals present, for variable periods of time, both a liquid and a vapor hazard to personnel in a contaminated area. An increase in the amount of agent disseminated per hectare increases the duration of hazard in the contaminated area.

a. Nerve Gas. The hazard produced by GB disseminated in a target area endures longer in liquid form than in vapor form. This is particularly true of low places in the terrain, such as shell craters and foxholes.

- (1) Liquid GB will remain in shell craters for extended periods of time. These craters should be avoided by friendly troops until tests with the detector kit prove negative. No minimum safe time can be prescribed before GB-contaminated craters can be safely occupied by troops. Troops entering or occupying a GB impact area must therefore mask until detector kits disclose the absence of GB.
- (2) GB vapor will begin to dissipate immediately after its employment. Troops designated to enter and occupy an area attacked with GB should be masked, until

tests indicate that casualty producing concentrations of the agent are no longer present. Low lying or wooded areas may retain GB vapor for even longer periods. For areas downwind of the target area, the passage of the toxic cloud determines safe entry times or the length of exposure of friendly troops in the path of the gas cloud. Due to drag effect and other variables, the gas cloud will tend to lengthen as it moves downwind. A safety factor of 10 minutes must be added to the time-length of the gas cloud to compensate for these variables. For example, when the wind speed is 10 miles per hour and the area over which the toxic cloud must travel is 1 mile wide, it would take a minimum of 16 minutes (6 minutes plus 10 minutes safety factor) before friendly troops could occupy the area unmasked.

b. *Mustard*. HD disseminated in a target area presents both a liquid and a vapor hazard to friendly personnel, varying in dosage principally in accordance with meteorological conditions and with other factors indicated in table II.

Table II. Duration of Hazard in a Mustard (HD) Contaminated Area

Time in hours and days indicates the approximate time after contamination that prescribed tasks may be safely performed with protection indicated under the meteorological and terrain conditions existing in the target area.

Task	Terrain	PROTECTION (Based on an average expenditure of from 240-1200 pounds of mustard per hectare)			
		With protective clothing and wearing masks		Without protective clothing ^{1 2}	
		Temperature (60°-80° F.)	Hot (above 80° F.)	Temperature (60°-80° F.)	Hot (above 80° F.)
TRAVERSAL ³ (Walking across area up to 2 hr).	Bare soil, sand, or short grass	0	0	36 hr ⁴	36 hr ⁴
	Low vegetation	4 hr	2 hr	36 hr ⁴	36 hr ⁴
	High vegetation, including jungle and heavy woods.	12 hr	6 hr	4 days ⁴	2 days ⁴

ADVANCE UNDER FIRE (Contact with ground, 1 hr; total time in area, 2 hr).	Bare soil or low vegetation	24 hr	8 hr	3 days ⁴	2 days ⁵
	High vegetation, including jungle and heavy woods.	2 days	24 hr	6 days ⁵	4 days ⁵
OCCUPATION (Without hitting ground, 24 hr).	Bare soil or low vegetation	1 hr	1 hr	4 days ⁵	3 days ⁵
	High vegetation, including jungle and heavy woods.	1 hr	1 hr	4 days ⁵	3 days ⁵
OCCUPATION (Involving advance under fire, 24 hr).	Bare soil or low vegetation	24 hr	8 hr	4 days ⁵	3 days ⁵
	High vegetation, including jungle and heavy woods.	2 days	24 hr	6 days ⁵	4 days ⁵

¹ For men walking in a contaminated area for 2 hours without protective clothing, the limiting factor is the vapor. If the traverse requires only a few minutes, it can be accomplished at earlier times than those given in the table.

² The approximate times at which troops could occupy areas without having to wear masks apply to men with or without protective clothing. The vapor hazard is the limiting factor.

³ For men with protective clothing, when traversal is made in daylight and areas of heavy contamination can be avoided or decontaminated, the times can be reduced to about one-half of those given in the table.

⁴ Wearing masks.

⁵ Not wearing masks.

CHAPTER 5

CAPABILITIES AND TECHNIQUES FOR EMPLOYMENT OF SMOKE AND FLAME

Section I. SMOKE

72. General

Smoke is employed to reduce the effectiveness of enemy visual observation. This is accomplished by projected smoke on enemy observation points, by emplaced smoke on friendly units and installations, and by projected or emplaced smoke in areas between enemy observation points and friendly units or installations. Some types of smoke can also be used to signal.

73. Types and Characteristics of Smoke

a. *Screening Smoke.* Screening smoke is generally white or gray since these colors produce the maximum obscuring effect. The tactical and logistical situations, including deception plans, will greatly influence the choice of the screening smoke effect to be used (fig. 5). Smoke can be employed to produce a—

- (1) *Smoke blanket*, a dense smoke concentration established over an area to prevent enemy observation and enemy visual precision bombing. Visibility in a smoke blanket is restricted, allowing limited friendly operations to take place.

- (2) *Smoke haze*, a light smoke concentration established over an area to reduce enemy visual observation during daylight or moonlight. Enemy observation is reduced while allowing friendly forces ease of operation within the haze. Visibility in a smoke haze is normally 150 yards to 200 yards.
- (3) *Smoke curtain*, a vertical smoke screen established between enemy observation and friendly units or installations to reduce enemy ground visual observation.
- (4) *Blinding smoke*, a smoke concentration placed directly on enemy positions to obscure enemy visual observation into friendly territory. Blinding smoke is projected by ground or air delivery means.

b. *Signaling Smoke*. Signaling smoke is available in several colors and can be used to—

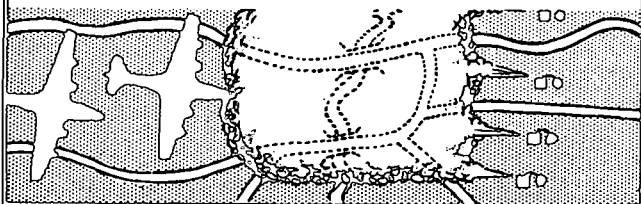
- (1) Mark enemy or friendly positions by smoke emission on the ground.
- (2) Transmit specific messages by prearranged color codes.

74. Effects of Weather

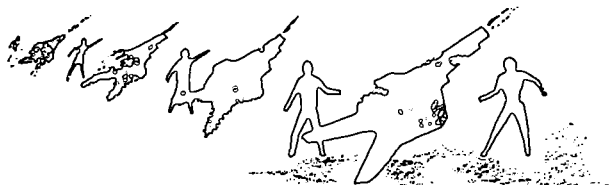
Wind speed and direction have a major influence on the effectiveness of a smoke screen. Other weather factors have little effect on smoke produced by smoke generators, and moderate effect on smoke produced by other means.

a. *Wind Speed*. The optimum wind speed for the establishment and maintenance of a smoke

A. SMOKE BLANKET PREVENTS AERIAL VISUAL OBSERVATION.



B. SMOKE HAZE REDUCES ENEMY VISUAL OBSERVATION.



C. SMOKE CURTAIN PREVENTS ENEMY GROUND VISUAL OBSERVATION.



D. BLINDING SMOKE PREVENTS ENEMY GROUND VISUAL OBSERVATION.

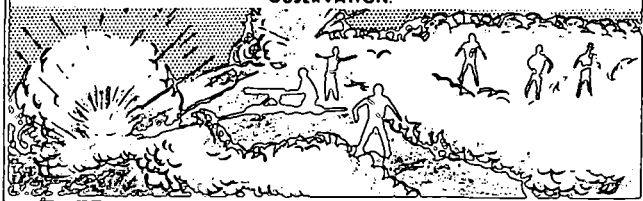


Figure 5. Types of smoke screens.

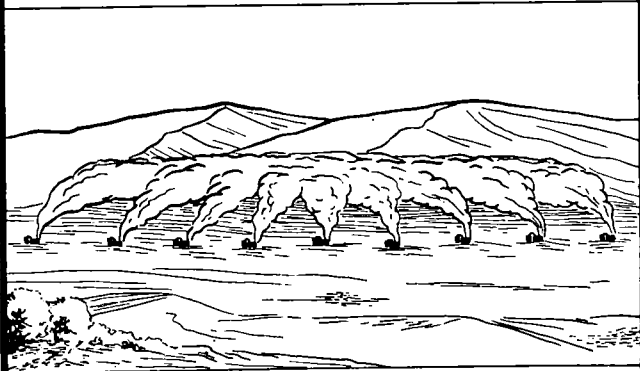
screen varies with the type of smoke being used. Smoke is not effective in wind speeds above 20 miles per hour.

- (1) *HC* and *FS* smoke are most effective at wind speeds from 5 to 15 miles per hour. In wind speeds below 5 miles per hour, *HC* smoke drifts too slowly and rises too high to be effective. In wind speeds above 15 miles per hour, *HC* smoke clouds are dispersed rapidly.
- (2) *WP* smoke is most effective at wind speeds from 10 to 20 miles per hour. In wind speeds below 10 miles per hour, *WP* smoke pillars excessively. In wind speeds above 20 miles per hour, the smoke cloud is torn apart and dispersed.
- (3) *SGF* smoke from smoke generators is most effective in wind speeds from 5 to 12 miles per hour (fig. 6). In wind speeds below 5 miles per hour, difficulty is experienced in producing a smoke screen of any appreciable depth. In wind speeds above 20 miles per hour, the smoke cloud is dispersed rapidly.

b. *Wind Direction.* Wind direction influences the location of emplaced smoke generators and the impact area for projected smoke. Since no long range forecast of local winds is entirely reliable, smoke operation plans must provide for winds in all directions. When *WP* is used for blinding or casualty effect, the munitions are placed directly on target regardless of wind direction.



THE SLOWER THE WIND, THE MORE VARIABLE THE WIND DIRECTION AND THE MORE QUICKLY THE STREAMS MERGE.



THE FASTER THE WIND, THE FARTHER THE STREAMS TRAVEL DOWNWIND BEFORE MERGING.

Figure 6. Effect of wind on merging of smoke clouds.

c. *Air Stability.* Smoke clouds are affected by temperature gradient conditions in the same way as toxic chemical clouds are (par. 43) but not to the same degree. In general, smoke can be used effectively under all but extreme conditions of air stability.

d. *Humidity.* Humidity has no effect on smoke except in the case of HC and FS smoke. The obscuring power and persistency of these smokes are best under conditions of high humidity.

75. Effects of Terrain

In general, smoke clouds are affected by terrain as described in paragraphs 47 through 50. Although level and unbroken terrain is the most favorable for smoke screens, smoke can be employed on any type terrain. On flat, unbroken terrain, smoke from mechanical smoke generators takes longer to spread out and merge. Obstructions tend to disperse smoke, causing it to cover a larger area and to create a more uniform smoke screen. Smoke tends to be evenly dispersed in wooded areas and remains longer in woods than in the open. Very rugged terrain consisting of large hills disperses smoke, causing holes in the smoke screen.

76. Methods of Dissemination

The dissemination method of choice for a particular operation is influenced by the tactical situation, desired results, conditions of weather and terrain, and availability of smoke munitions.

a. *Large Area Coverage in Friendly Territory.*

Large area coverage in friendly territory is best accomplished by mechanical smoke generators.

b. *Coverage in Enemy Territory.* Projected smoke is the best means of establishing smoke coverage in enemy held territory. WP delivered by mortar, artillery, or rockets is best suited for this purpose. The antipersonnel qualities of WP produce a bonus effect.

77. Employment of Smoke in Friendly Areas

Smoke may be used to deny information to the enemy by preventing observation over a particular area and to deceive the enemy by drawing attention to nonvital areas. By using a smoke screen to draw attention to an unimportant target or area, the enemy may be induced to attack the target and to expend ammunition with no commensurate gain or advantage. Smoke is also used to conceal gun flashes, artillery positions, construction sites, main supply routes, troop maneuvers, and other activities in the attack.

a. *Attenuation Effects.* Smoke may be employed to attenuate thermal radiation from a nuclear burst and thereby reduce friendly casualties from this source. Smoke will also protect personnel against the flash caused by a nuclear burst.

b. *Dummy Screens.* Deception is one of the prime capabilities of smoke. With the development of nuclear weapons, deceiving the enemy by the use of smoke has become more necessary than ever before.

c. *Protection of Rear Areas.* Smoke may be

effectively employed in defense of vital installations to minimize personnel casualties and damage or destruction of materiel and equipment resulting from low level attacks by enemy aircraft. Although smoke will not affect enemy precision radar bombing from high altitudes, it will have an adverse effect on enemy air attacks when aircraft are flown close to the ground to avoid early detection by radar. Smoke restricts the ability of the airplane pilot to make necessary visual alignment on his target to insure strafing and bombing accuracy and deceives him as to the actual location of the target. As a result, concealment of the target with smoke can materially reduce the effectiveness of enemy strafing and low-level bombing attacks. Smoke creates another advantage for defending forces because pilots of high-speed aircraft tend to avoid flying into smoke clouds when close to the ground, due to the additional hazard involved. Enemy aircraft become more vulnerable to anti-aircraft artillery when they fly higher to avoid the smoke, for they can be detected by radar at a greater distance from their objective. The use of dummy screens for deception is desirable, in conjunction with the use of smoke, to cover the installation to be protected.

Section II. FLAME

78. General

Flame is used to exploit man's natural fear of fire, and to cause personnel casualties in inclosed spaces. Destruction of materiel and equipment is

not a primary use for flame and such effects should be considered as bonus. Flame is rarely used primarily for its incendiary effect. Flame can be delivered to a target by portable and mechanized flamethrowers, by expedient flame munitions positioned by troops, and by air delivered fire bombs.

a. Flame Weapons. Ground flame weapons are antipersonnel, special purpose weapons. They are employed principally in the reduction of fortified positions during offensive operations and against mass enemy attack during defensive operations. Portable flamethrowers, mechanized flamethrowers, and expendable field expedients are employed by infantry, armored, and airborne units. The one-shot portable flamethrower can be used in a single operation and then be evacuated by normal battlefield recovery techniques. Integral-type mechanized flame weapons may be organic to combat units.

b. Flame Gunners. Infantry personnel are trained to employ portable flamethrowers. Assault teams for the employment of flamethrowers are formed and trained within the rifle company as required. Mechanized flamethrowers are employed by trained crews in armored units.

c. Incendiary Munitions. Incendiaries are used, primarily, for destruction of equipment and materiel. Equipment and materiel destruction incendiaries are positioned by troops.

79. Types and Characteristics

a. Flame. The effect of flame on a target is primarily dependent on the consistency of the fuel.

Thickened fuel can be projected from a flame-thrower to a greater range than unthickened fuel. Thickened fuel burns longer on the target, burns on water, clings to the target, and in some instances can be ricocheted around a corner into an otherwise inaccessible target. However, unthickened fuel can envelop a larger target. Since unthickened fuel burns faster than thickened fuel, a greater asphyxiating effect is obtained.

b. Incendiaries. Incendiaries produce an intensive localized heat. They are used to fuze nonflammable materiel, such as abandoned artillery weapons, so that they cannot be used.

80. Effects of Weather

Wind is the most significant weather factor affecting the employment of flame. Weather has little effect on incendiaries.

a. Wind. Flame from flamethrowers is easily influenced by wind direction and speed. A strong wind will affect the range and deflection of the flame rod and may break it up before the flame reaches the target.

b. Precipitation. Precipitation decreases the incendiary effect of flame on the target. Thickened fuel will float on water and continue to burn effectively.

81. Effects of Terrain

Terrain has little effect on flame. Cover provided by terrain irregularities or man-made features may make the placement of flame on the target difficult.

82. Methods of Dissemination

Flame munitions have equal applicability for ground or air delivery as opposed to incendiary munitions which are disseminated chiefly by the Air Force on strategic targets. Fire bombs are used by the Air Force in support of ground operations against enemy troops. Flame can be disseminated by the following:

a. Portable and Vehicle-Mounted Flamethrowers. Flamethrowers can project flame toward a target in a single burst or a series of bursts. The range varies with the type and consistency of the fuel, wind speed and direction, applied pressure, and the size of the dispersing nozzle. The duration of each burst is controlled by the gunner. The accuracy of the projected rod of flame is dependent on the consistency of the fuel mixture, wind, and experience of the gunner.

b. One-Shot Portable Flamethrower. The one-shot portable flamethrower is especially suited for patrols, amphibious and airborne operations, deep penetrations, and operations where recovery and refueling are not feasible. Expended flamethrowers may, however, be evacuated through normal channels and prepared for reuse.

c. Flame Field Expedients. Flame field expedients consist of improvised containers filled with fuel, and other materials generally available in the field such as explosives, fuses, and grenades. Flame field expedients include but are not limited to—

(1) *The flame land mine*, an improvised con-

tainer with 5- to 55-gallon capacity filled with thickened fuel, a firing system to ignite the fuel, and a bursting charge to scatter the fuel over an effective radius or to project it over a predetermined area. Flame land mines may be wired for electric detonation, trip-wire actuated, or booby trapped.

- (2) *A one-shot expedient*, an empty artillery shell casing filled with thickened fuel and equipped with an explosive charge acting as a propellant, a wooden disc acting as the piston, electric blasting caps, a WP hand grenade acting as igniter, wire, and blasting machine or battery.
- (3) *The flame illuminator*, an expedient for limited illumination of selected areas of battlefield, consisting of a container (up to 55- gallon capacity) filled with thickened fuel, an incendiary hand grenade or illuminating flare to ignite the fuel, an explosive charge such as detonating cord, and a firing system. The Husch flare is a specific type of flame illuminator that permits thickened fuel to be vaporized and expelled as a burning jet through a small hole.

83. Employment of Flame Land Mines and Other Flame Field Expedients

Flame land mines and other flame field expedients are defensive in nature. They may be used alone or to supplement other type minefields for

casualty effect and for battlefield illumination. They may be employed along the edges of a composite minefield, used to supplement explosive demolitions or as artificial obstacles, used to illuminate the battlefield at night, or used by security forces forward of the battle position to warn of enemy approach at night. When emplacing the flame land mine in a composite mine field, consideration must be given to the effects of flame on other obstacle components, such as trip wire, electric detonating wire, or the chemical agent of the chemical land mines. The presence of these expedients in a composite minefield should be marked and posted on map overlays as prescribed in engineer directives.

84. Employment of Flamethrowers

The flamethrower is a relatively short range weapon and, to be employed effectively, flame gunners must close with the enemy. Each type of flamethrower, because of its individual characteristics, requires a special technique of employment. Portable flamethrowers, with a maximum range of approximately 55 yards, are employed with assault rifle squads. Vehicle-mounted flame throwers, with a maximum range of approximately 225 yards, are normally attached to units of at least infantry rifle company size. Flamethrowers are employed to—

a. *Kill or Disable Personnel.* Flame is projected directly on personnel either in the open or through openings in fortifications or armored vehicles. Personnel become casualties by heat injury associated

with burning or by suffocation due to depletion of oxygen if the target is a closed space such as a cave or pillbox.

b. Demoralize Personnel. Because of the innate fear of uncontrolled fire, flame is used to demoralize personnel in caves, fortified bunkers, pillboxes, immobilized tanks, buildings, ditches, and trenches. Flame employed in mass is especially effective in demoralizing assaulting enemy troops.

c. Assist in Clearing Areas. Flame may be used to burn up camouflage, vegetation, and other inflammable materials. It may be used to decontaminate areas contaminated with chemical agents or to expose enemy emplacements such as bunkers and minefields.

85. Service Support

Mixing of fuel and filling and preparation of flamethrowers will be accomplished by personnel of the chemical combat support platoon, augmented by using personnel when required. Fuel mixing and service equipment will be organic and operated by personnel of the platoon. Flamethrower servicing personnel will service flamethrowers in the vicinity of the using unit. Flame field expedients will be prefabricated by the chemical combat support platoon and furnished to using units. In large scale operations, the platoon will supervise preparation and emplacing of flame field expedients by using units.

CHAPTER 6

TACTICAL EMPLOYMENT OF CHEMICAL AGENTS

Section I. INTRODUCTION

86. General

Chemical agents may be used tactically to assist the field commander in accomplishing his mission. The choice of the agent depends on the mission and objective of the commander, his plan of operations, the weather and terrain, the effects desired, the availability of agent and munition, and how soon friendly troops will occupy the area involved. The proper employment of any toxic agent requires staff consideration of the technical problems relating thereto, such as the capabilities of the available weapons for delivering the agent, ammunition requirements, and troop safety considerations. Plans for the employment of toxic agents must be integrated into the unit scheme of maneuver. Possible uses of toxic agents in conjunction with other munitions are to—

a. Soften Enemy Positions. Toxic agents are used against strongly defended enemy positions to weaken the position by inflicting casualties among enemy troops.

b. Assist in Protection of Flanks. Toxic agents may be employed to contaminate terrain and thus hamper enemy operations against an exposed

flank. This forces the enemy either to avoid the area or to accept the risk of casualties from crossing the area.

c. *Assist in Isolating Enemy Positions.* Toxic agents can be employed to contaminate enemy routes of supply and reinforcement and isolate enemy positions. Use of toxic agents for such contamination should be coordinated and compatible with the planned maneuver of friendly forces.

d. *Hinder Support of Enemy Operations.* Toxic agents may be used against enemy troops in reserve and assembly or concentration areas. Toxic agents may also be used on enemy artillery, mortar, and missile positions; supply installations; and observation posts to cause casualties and to restrict the use of the position or to force its evacuation. Chemical interdictory fires restrict enemy operations by producing casualties, limiting the use of terrain and facilities, and enforcing prolonged wearing of the mask. Contamination of demolitions and damaged vital transportation facilities delays repairs by forcing construction personnel to work in protective clothing and masks. Under favorable wind conditions, large portions of the enemy rear areas are subjected to downwind hazards from concentrations capable of producing casualties.

e. *Hinder or Canalize Enemy Advance.* Toxic agents may be used to reinforce natural barriers or engineer obstacles in fixed-type defenses to hinder or canalize the enemy advance. Liquid contamination supporting a minefield or obstacle slows traversal of the obstacle, complicates clearing and

breaching operations in minefields, and delays repairs of demolitions.

f. Produce Casualty Effect With Minimum Destruction. Key facilities earmarked for future use by friendly forces can be attacked with toxic agents in preference to HE or atomic munitions. Casualties to key operating personnel may limit enemy use of the facility with subsequent minimum need for reconstruction by friendly forces.

87. Planning the Employment of Toxic Agents

Fundamental factors which must be considered when planning the employment of toxic agents, and the sequence in which they are normally considered by the commander and his staff are—

a. Selection of Targets. The selection of suitable targets for the employment of toxic agents requires coordination of map, ground, and air reconnaissance; intelligence studies; and staff evaluation of enemy installations and areas suspected of containing remunerative targets. Targets which are resistant to attack with high explosives but vulnerable to toxic agents are normally selected for attack with toxic agents.

b. Results Desired. Before a suitable toxic agent can be selected for use against a selected target, the results desired must be determined. The tactical situation may require immediate, delayed, or the threat of continued casualty effects against enemy personnel who are either protected or unprotected against certain agents; hindering enemy use of terrain or materiel for specified periods of

time; denying the enemy use of important installations without destroying them, so that they might ultimately be used by friendly forces; or the neutralization of enemy fortifications which are not vulnerable to conventional high explosives or are not appropriate for attack by nuclear weapons.

c. Selection of a Toxic Agent. The toxic agent that will most effectively accomplish the results desired is selected for employment against the designated target. For example, a toxic agent can be selected which will have immediate or delayed effects on enemy troops. In selecting the agent to use against an enemy, consideration must be given to the quality and type of protection available to enemy troops, the state of enemy CBR training and morale, the enemy CBR warning system, enemy CBR detection and identification devices, enemy psychological reactions, the climate and terrain of the battlefield, and friendly toxic agent logistical capabilities and limitations.

d. Selection of Weapons. The weapons which can most effectively deliver the designated agent to the target should be selected. In recommending the delivery means, consideration must be given to the capabilities of and the availability of ammunition for the weapons. To cover large target areas, it may be necessary to mass all available weapons to obtain target coverage.

88. Coordinating the Employment of Toxic and Nontoxic Chemical Agents

The employment of toxic chemical agents in an operation must be closely coordinated with other

current operations and with operations of adjacent friendly forces. Contamination of terrain essential to future plans is generally avoided. Downwind hazards expected to cross unit boundaries require coordination with the unit affected and approval of the next higher command echelon.

a. *Toxic Agents.* Employment of toxic chemicals is normally coordinated at division or higher level but may be delegated to lower echelons in special situations (FM 100-1).

b. *Nontoxic Agents.*

- (1) Use of chemical smoke for extensive screening operations requires staff coordination and supervision to insure that the screen is effective and that it does not interfere with friendly operations. Tactical control of smoke operations must be with the highest tactical commander concerned with the operation so that the overall effect of the smoke on the mission may be properly evaluated and exploited. Friendly forces must be notified of the use of smoke so that they can plan to take maximum advantage of the concealment afforded and be prepared for limited interference by the smoke. Use of smoke by battle group organic weapons needs to be coordinated at higher levels only when there is a possibility of the smoke being effective *outside* the unit's zone of operations.

- (2) The authority to use flame with assault

teams and in defense of forward positions is normally delegated down to battle group and company level. Utilization of flame land mines and other flame field expedients in protective minefields is authorized at battle group level. Care must be taken to properly record the location of flame field expedients that are activated by explosives. These expedients fall in the same category as HE land mines and must be treated with the same precautions.

Section II. OFFENSIVE OPERATIONS

89. General

In offensive operations, the commander selects an objective which facilitates or promises destruction of the enemy's forces or their will to fight. The main attack maneuver may be an envelopment or a penetration, characterized by a relatively narrow zone of action and maximum support by all weapons. Toxic chemical agents are usually employed in mass to support the main attack. They may be used alone or to increase the effectiveness of other supporting fires. They are best used to circumvent the defender's protection against conventional HE munitions. Toxic chemical artillery fires are normally integrated into preparatory fires against known or suspected targets.

90. Chemical Attack for Nonpersistent Effect

Chemical attacks for nonpersistent effect are

made against occupied targets, including those in the path of the attacking forces. Prior to the assault, GB may be used in the chemical attack to produce casualties among enemy troops in the area selected for the penetration and to assist the assaulting elements in the initial breakthrough. Such attacks may be made against reserves posing a threat to the success of the attack. When practicable, such attacks should be so coordinated as to enable friendly troops to assault unmasked. However, enemy counterpreparation fires placed on the attacking force may include sufficient toxic agents to require masking by friendly troops. Under favorable wind conditions when the wind will not produce downwind hazards on friendly forces, GB can be used in a chemical attack against occupied or suspected targets opposing our forces well ahead of the time of our attack. Such attacks are particularly effective at night because of inversion conditions. Dangerous concentrations, varying from lethal to incapacitating, may exist for several miles downwind. Casualties may result among personnel in the chemical ammunition impact area and in the path of downwind cloud travel. Large portions of the enemy rear areas can be harassed with the constant threat of casualties among personnel who are asleep or in isolated areas. Deliberate harassment can be obtained by intermittent chemical fires maintained over long periods of time. Sleep is thereby made more difficult, and the physical demands of long periods in masks produce debilitation and lower morale of target personnel.

91. Chemical Attack for Persistent Effect

Chemical attacks for persistent effect are made on target areas that friendly forces do not intend to enter immediately because the resulting contamination has the effect of an obstacle to maneuver. HD may be used in a chemical attack to help protect the flanks of the attacking forces. Such attacks may be made against troops and are especially effective against enemy reserves. They can be made to contaminate "switch" or alternate defensive positions in an attempt to fix the enemy in preselected uncontaminated positions for attack with other weapons. Such attacks are made to neutralize enemy observation posts and artillery positions. HD is not as effective as GB for use in rear areas for combined impact area and downwind casualty and harassing effects. This lesser effectiveness results from the lower toxicity and limited downwind hazards from mustard vapor.

92. Smoke

Smoke properly used is an effective aid in the attack. Screening smoke is used to blind hostile observation positions, to blind enemy individual and crew-served direct fire weapons, to conceal the attacker's maneuver, and to assist in achieving surprise. It also may be used for deception and to conceal activities and installations, as in river crossings. Smoke is also used to mark targets for air attack and to mark the bomb safety line.

93. Flame

Flame, delivered by fire bombs on selected tar-

gets by the Air Force followed by portable and mechanized flamethrowers in the ground assault, may be used to assist in the reduction of strongly fortified positions and in the initial breakthrough. Flame may be used, with precaution, to make safe lanes through forward contaminated areas. The process of burning off contaminated areas may produce high concentrations of toxic vapor temporarily. Portable and mechanized flamethrowers can be used to assist assault teams in the reduction of strong points. Terrain permitting, mechanized flamethrowers are preferable for use against fortifications because of the armor protection and greater volume of flame fuel. Against deeper targets, fire bombs are effective against armor, trains, and motor transportation.

94. Employment of Toxic Chemicals in Conjunction With Nuclear Attack

When used in conjunction with nuclear weapons, the basic considerations for the employment of toxic chemicals remain unchanged. Toxic chemicals employed to produce a nonpersistent effect are especially useful for employment against targets when nuclear weapons are not appropriate due to troop safety or the necessity of avoiding the creation of obstacles. When employed in conjunction with nuclear weapons, the chemical attack for nonpersistent effect should follow nuclear detonations. Typical uses are to :

a. *Cause Casualties in the Buffer Zone of Close-In Targets.* Because of troop safety requirements in an attack of close-in targets with nuclear weap-

ons, it may be often necessary to offset in depth the desired ground zero to avoid undue hazard to friendly troops. The radius of effect of severe damage of the nuclear weapon selected may not cause significant casualties in the crust of enemy forces immediately opposing friendly forces to permit quick penetration. GB can effectively be employed in this buffer zone to help friendly troops through this initial crust of resistance, if wind conditions permit or the commander is willing to conduct initial phases of the operation with masked troops.

b. Cause Casualties Without Creation of Obstacles. The use of nuclear weapons in wooded or built-up areas may create serious obstacles to movement of friendly forces, due to tree blowdown in forests or creation of rubble in cities. GB can be employed in designated areas without causing obstacles to movement.

c. Cause Casualties Without Contamination. Most nuclear weapons which are tactically successful (with a height of burst low enough to achieve significant target effect) create an area of neutron-induced gamma contamination. The radius of hazard of this induced contamination approaches the radius of effects for severe damage to dug-in troops. Thus, the maneuver of foot troops may be restricted to the area outside the radius of severe damage effects of the weapons used. Mounted troops are not so restricted, provided the area is relatively open so that any obstacles from tree blowdown and rubble of built-up areas can be avoided. When plans are made for the use of nu-

clear weapons in support of an attack, selected ground zeroes are sufficiently separated to leave a path which is free of induced contamination and obstacles to movement for attacking forces. Thus, the attacking forces may still be faced with the resistance of enemy forces in the path of attack. These enemy forces will not have suffered severe casualties from the nuclear bursts to either flank, although considerable disorganization can be expected. GB can be effectively employed in this area to capitalize on the disorganization and shock of enemy troops resulting from the nuclear strikes, with promise of a high casualty level. The GB attack should be made immediately after nuclear fires to achieve surprise effects before control and discipline are reestablished.

95. Breaching Composite Minefield

Personnel effecting a manual breach of an uncontaminated mine field should wear a normal combat uniform (impregnated) and should carry protective mask and gloves ready to put on quickly to minimize the effect of "leakers" and chemical mine explosions. A complete ensemble of impermeable protective clothing and mask should be worn, if possible, when effecting a breach by mechanical or explosive means or a breach through a contaminated area. Minefields are normally covered with fires of automatic weapons. These fires should be neutralized first, followed by rapid breaching and traversal of the barrier using mechanized vehicles when available. Composite barriers must be accepted as normal situations and must not be per-

mitted to canalize or slow up the advance of attacking forces.

Section III. DEFENSIVE OPERATIONS

96. General

In defensive operations, the commander selects, organizes, and holds a battle position to gain time, pending the development of more favorable conditions for undertaking the offensive, or to economize forces on one front for the purpose of concentrating superior forces for a decisive action elsewhere. In a position defense, the bulk of the defending force is organized in selected tactical localities, with the reserve disposed in depth. In a mobile defense, the bulk of the force is held as a mobile striking force with the remainder manning the forward defensive positions. Toxic chemicals may be employed on enemy forces concentrating for the attack, in support of forces along the forward edges of the battle area (FEBA), or to assist the counterattack or striking force. Toxic chemical fires are preplanned and integrated into the overall fire support plan. Toxic chemical fires should be so planned as to subject enemy forces to effective concentrations of toxic chemicals as early as practicable in the operation and so achieve maximum effect forward of the FEBA.

97. Chemical Attack for Nonpersistent Effect

Chemical attacks for nonpersistent effect are made against enemy troops at any time or place that they present a profitable target to inflict

casualties and to slow down the attack by forcing troops to wear masks. GB may be used in a chemical attack primarily on targets in front of the FEBA prior to the time the attack develops. Profitable targets forward of the FEBA are known or suspected troop concentrations of reserves, attack position, command posts, and artillery positions. GB is also very effective at night on known or suspected troop concentrations to produce casualties in the impact area and, also, harassment and the threat of casualties for extensive areas downwind. By proper selection of targets and time spacing of the GB fires throughout the night, enemy personnel in the enemy rear can be subjected to casualty concentrations or can be kept in masks under frequent alerts.

98. Chemical Attack for Persistent Effect

Chemical attacks for persistent effect are made to contaminate terrain which is important to the enemy scheme of maneuver such as avenues of approach, key terrain features, artillery positions, and assembly areas. Toxic chemical contaminations have special defensive value since concentrations established before the attack retain effectiveness throughout the attack. Terrain contaminated with toxic chemicals hampers attacking enemy troops by forcing them to wear protective clothing and equipment or to take a calculated risk without protective clothing in traversing the contaminated area. Toxic chemicals may be used to contaminate critical targets which have been destroyed by demolitions, thereby delaying repairs.

Terrain contaminated with toxic chemicals must be periodically recontaminated in order to effectively restrict enemy use of the terrain.

99. Smoke

Smoke is used defensively to obscure operations from the enemy and to reduce the effectiveness of fire (including visual precision bombing). Since defensive tactics will depend largely upon observation, firepower, and counterattack, the use of smoke must be well planned and coordinated. In enemy terrain, smoke is used principally to blind enemy observation posts. In friendly terrain, smoke may be used to deceive the enemy of the location and disposition of defending forces and to conceal movement of friendly forces such as in the counterattack, withdrawal from action, and exchange of troops and equipment.

100. Flame

Flame is used to kill, incapacitate, and demoralize enemy troops assaulting friendly positions. Portable and emplaced flamethrowers may be positioned along the forward edge of the battle area and integrated into the defensive plan. Vehicle-mounted flamethrowers are held in general support as part of the reserve, although they can be employed along the main battle position. Trip wire or electrically actuated flame landmines and flame illuminating devices may be used to detect infiltrating enemy forces during periods of darkness and inflict casualties.

101. Toxic Chemical Minefields and Barriers

Toxic chemical land mines are habitually integrated with HE mines or other obstacles for the purpose of increasing the hazard of breaching the barrier. Integration of chemical mines into *existing* HE mine fields is accomplished by adding rows of chemical or chemical and HE mines mixed to the edges of the existing HE minefield, *not* by re-entering the minefield. Integrated chemical-HE minefields are normally a part of the division (or higher) defensive plans. These composite minefields are most effective when personnel-contact-activated chemical mines are employed. The presence of HE mines reduces traversal speed, thereby forcing ground exposure to the toxic contaminated area, while toxic chemical land mines slow breaching operations by discouraging the employment of explosive rapid mine-clearing techniques. Chemical mines should be fitted with anti-lift devices. They should be emplaced in vegetated areas.

a. Composite Minefield. The composite minefield is used to deflect enemy attacks into unfavorable terrain where enemy troops present lucrative targets. Chemical mines are integrated into the standard minefield in a nonuniform pattern. Uniform contamination of the minefield is not necessarily desirable nor practicable. Chemical mines may be substituted for blast type HE-AP mines on the basis of one for approximately every fourth cluster.

b. Toxic Chemical Minefields. The M1 chemi-

cal land mine is designed for simultaneous detonation of the entire field. These mines are connected with detonating cord and are electrically detonated. This type of mine is not suitable for use on composite minefields because of the risk of detonating HE mines when the chemical mines are detonated. Minefields which contain only toxic chemical land mines are rarely used. The M1 statically fired toxic chemical mines may be used to contaminate demolitions such as bridge approaches. They may be fired by deliberate simultaneous detonation of all or major parts of the minefield. To obtain maximum contamination results when used as a purely chemical minefield, the toxic chemical mines must not be detonated prematurely. They should be detonated just prior to the entry of enemy troop units into the area. The authority to detonate toxic chemical minefield, the toxic chemical mines must gated to the lowest echelon responsible for defending the mined area.

c. Toxic Barriers. To remain effective, toxic contaminations on barriers or barrier minefields must be periodically refreshed. This can be accomplished by heavy mortars or artillery.

d. Coordination. Chemical mines are normally not employed in protective or defensive minefields except as portions of these fields are integrated into the overall barrier system. Troop safety problems and the delayed casualty effect of mustard limit the usefulness of chemical mines in close-in minefields. Chemical mines are normally employed in barrier minefields and can be authorized by division commanders. They may also be employed in nuisance

minefields authorized by Army and higher commanders. See FM 20-32 for additional information on employment of land mines.

e. Troop Safety. When wind conditions are unfavorable, the responsible commander must insure troop safety measures for friendly personnel prior to the detonation of toxic chemical mines. Detonation of a close-in M1 chemical minefield, under adverse wind conditions, can result in a downwind mustard vapor hazard for several thousand yards. When available, contact-activated chemical mines are not expected to create a significant downwind hazard since only small groups or single mines are apt to be detonated at any one time.

102. Retrograde Movements

A retrograde movement is any movement away from the enemy. Types of retrograde movements are: withdrawal from action either by day or night, delaying action, and retirement. Every retrograde movement made from contact with the enemy must be initiated by a withdrawal from action. Under such circumstances, flanks must be protected to avoid envelopment of the main forces. Chemical agents can be used to assist friendly forces to withdraw from action or to retire by protecting their flanks and by delaying the hostile advance. The interference imposed by nuisance minefields, including toxic chemical land mines and toxic chemical contaminations of natural terrain obstacles, is particularly effective in delaying the movement of enemy forces against successive posi-

tions by requiring clearance and decontamination or by acceptance of personnel losses.

a. *Toxic Chemical Agents.* Principles of employment for toxic chemical agents in the defense apply generally to retrograde movements. More freedom exists in nuisance mining. Contamination of demolitions delays repairs and gains time for the defender.

b. *Smoke.* Smoke is used to screen the withdrawal of friendly forces from one delaying position to another in daylight. Priority is given to assembly areas and to key road junctions and defiles along the routes of movement of friendly forces to the rear. Smoke is also used to permit hard pressed covering forces to disengage from action during daylight. Motorized or mechanized units can carry a limited number of smoke pots to cover daylight withdrawals. Extensive use of smoke will normally require attachment of smoke generator units to the covering force. Artillery and mortars fire smoke to blind enemy observation posts and to establish screens to cover friendly forces.

c. *Flame and Incendiaries.* Flamethrowers and flame field expedients have limited application in retrograde movements. Incendiaries are provided friendly troops for the destruction of equipment in imminent danger of capture.

Section IV. SPECIAL OPERATIONS

103. General

The techniques for the employment of chemical

agents in support of offensive and defensive operations apply generally to special operations. Modification of techniques, tactics, or other considerations may be required in the case of the following special operations because of the characteristics of the area, the nature of the operation, special conditions under which the operations are conducted, or a combination of these factors. See FM 100-5 and the list of 30, 60, and 70-series field manuals in appendix I for principles and doctrine on the conduct of special operations.

104. Attack of a Fortified Position

In the attack of a fortified position, the commander may bypass and neutralize the position and later reduce it by siege or by attack from the rear. If isolation by an enveloping maneuver is not possible, the commander may reduce the fortified position by a direct attack against a weak area (FM 31-50). The principles for the employment of chemical agents in the offense apply.

a. Chemical Attack for Nonpersistent Effect. Chemical attacks for nonpersistent effect are effective against hostile fortifications not protected by gas filtration equipment. Near misses close to an embrasure with GB ammunition projects a portion of the GB cloud into the fortification. Direct hits in the embrasure, as is the case with HE munitions, are not required. Area attacks with GB are made on suspected areas when intelligence on the exact location of individual fortifications is inadequate. Individual, well located fortifications are attacked as point targets.

b. Chemical Attack for Persistent Effect. Chemical attacks for persistent effect are made against flanking and reserve positions from which enemy counterattacks could be launched. They may also be made against enemy strong points which are bypassed and need not be occupied by friendly forces immediately. Troop safety considerations, particularly downwind vapor hazard and the presence of persistent contamination, must be carefully regarded before a chemical attack is made.

c. Smoke. Smoke is used to screen the daylight movement of direct-fire weapons into position. Smoke is also used to conceal the movements of assault detachments by placing smoke directly on flank positions capable of firing on friendly troop units. Smoke may be placed directly on fortified positions until flamethrowers, demolition teams, and advancing infantry are in final assault positions. The use of smoke must be carefully coordinated to reduce interference with friendly supporting fires.

d. Flame. Flame can be used to make safe lanes through contaminated barriers. Flamethrowers are used against embrasures of fortifications to neutralize the fortification and to cover the movements of demolition teams.

105. River Crossings and Defense of a River Line

The attack across an unfordable river requires special technical and tactical preparations proportionate to the size of the river and the relative strength of the opposing forces. Troops and special equipment are assembled as indicated by the situa-

tion. Alternate plans are prepared to provide for changes in the weather and tactical situation. See FM 31-60 for additional information on river-crossing operations.

a. Toxic Chemicals. The principles of employment of toxic chemicals in the offense and defense apply.

b. Smoke. Smoke is used to conceal preparations for the assault crossing, to assist in the deception schemes, and to help protect the actual crossing site until prescribed phased objectives are taken (fig. 7). The use of smoke must be coordinated and controlled by the highest echelon participating in the river crossing. Smoke plans are made to conceal the vital areas (assembly areas, attack positions, and crossing sites) regardless of meteorological conditions. The smoke should cause minimum interference with operations of the supported unit and with operations of friendly units on the flanks. A smoke haze offers minimum interference with friendly operations and is generally adequate to provide concealment.

- (1) The size of the area covered by smoke must exceed that actually required for the preparation and the assault. The area covered by smoke must include several potential crossing sites, likely assembly areas, and suitable access roads.
- (2) Smoke can be generated by chemical smoke generators operated on the friendly shore, in boats, or on the far shore as soon as foothold is secured; by smoke pots

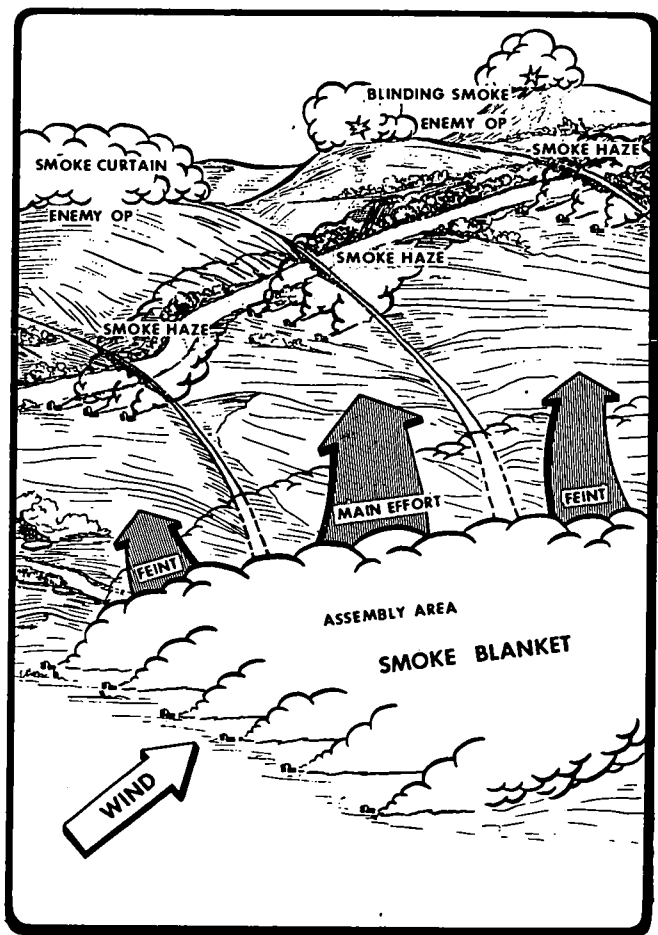


Figure 7. Smoke used in support of a river crossing.

floated down the river or released from boats; by artillery and mortars; and by aerial delivery. Direct fire weapons, artillery, and mortars fire smoke on the far shore observation posts and supplement smoke established by generators and smoke pots.

- (3) Dummy smoke screens are particularly effective in protecting river crossings by drawing enemy fire and observation and preventing the massing of enemy forces at the crossing points. Dummy smoke screens should be logically located and similar in extent to the real screen so that the enemy is unable to determine which screen is actually concealing the vital area. Smoke may be used to conceal an area in which demonstrations or feints are prepared to present an appearance of activity which does not actually exist. Skillful use of smoke serves to confuse the enemy and may cause him to shift his fires to unremunerative targets.
- (4) The assault crossing under cover of smoke should be rehearsed as in any other operation under unfamiliar conditions.

106. Combat at Night

Night combat is characterized by a decrease in effectiveness of aimed fire and an increase in the difficulties of movement, observation, communication, and security. Fog or smoke produces condi-

tions similar to darkness. Toxic chemical agents can be employed to compensate for the decrease in effectiveness of aimed fire by the blanket coverage of selected enemy held areas. However, toxic chemical fires must be planned on the basis of daylight reconnaissance and observation. Toxic chemicals are more effective at night because of stable meteorological conditions and extensive downwind travel. Contaminated areas are more difficult to avoid or traverse at night.

a. Offense. Use of toxic chemical agents in the path of attacking forces or upwind of the attack is generally not feasible because of control and troop safety problems such as: impairment of night vision in masked personnel or those suffering GB eye effects, the difficulty of determining the presence of GB with detector kits, and the difficulty of making eye checks for pin pointing of pupils. When GB is used in night attacks on targets that would pose a troop safety problem to friendly forces, it should be used well ahead of the time attacking forces enter the impact areas so that hazards are largely dissipated. Deeper targets beyond the objective, such as reserves, are good toxic chemical targets provided wind direction is favorable or targets are beyond the range of hazardous downwind cloud travel for friendly troops. Smoke and flame have little application in night attacks.

b. Defense. The principles of the employment of toxic chemicals in the defense apply. Flame field expedients may be integrated into protective mine fields and the barrier system to give early warning of an enemy night attack and to inflict casualties.

107. Combat in Woods

Combat in woods, like combat in towns, is characterized by difficulty in observation and control of troops, by reduced effectiveness of fire and observation, and by increased importance of close combat. The principles of employment of toxic chemicals, smoke, and flame in the offense and defense apply. Special problems which affect the employment of toxic chemicals are—

a. Extensive blowdown caused by nuclear weapons limits maneuver of friendly forces. GB is used for quick casualty effect in wooded areas where blowdown would cause unacceptable obstacles to maneuver.

b. The persistency of toxic clouds is increased in wooded areas. The minimum air turbulence in wooded areas results in high vapor concentrations in the impact area and a small area coverage from the initial cloud merger and movement. There may be secondary liquid hazard from dripping of the agent from trees over a period of time. Prolonged wearing of the mask will be normal.

c. Prediction of downwind toxic cloud travel for troop safety purposes is difficult and inaccurate. In general the length of downwind cloud travel is greatly reduced. This is somewhat offset by increased persistency close to impact areas.

d. Natural cover and concealment afforded by the woods make target acquisition difficult. The area coverage capability of toxic chemicals thus takes on increased importance.

e. Vegetation enhances the casualty effect of mustard.

108. Mountain Operations

Mountain warfare is characterized by terrain which retards and restricts mobility and reduces effects of fire, and by heights which dominate valleys and lines of communication by observation and fire. Ground observation, defiladed positions, and control of passes are very important. Bunkers, caves, and prepared positions on reverse slopes can provide excellent cover to the defender and are almost completely invulnerable to HE munitions and, somewhat, to nuclear weapons as well. Mountain terrain thus provides excellent cover to the defender and limits the effectiveness of the fire of heavy weapons. See FM 31-72 for further detail on mountain operations.

a. *General.* Terrain and weather in mountainous areas greatly influence the use of chemical agents. Prevailing winds in the area are altered by local wind currents along the valleys and by air currents and air movement up or down the mountain slopes. Prediction of the direction and the extent of cloud travel is difficult and requires knowledge of local conditions. Chemical clouds tend to be funneled along the valleys, with higher vapor concentrations along the valley floor than on the slopes.

b. *In the Offense.* In offensive operations, friendly troops attempt to seize critical terrain features offering the best opportunities for flank-

ing action, effective supporting fires, and advantageous approaches to the decisive objective.

- (1) *Chemical attacks for nonpersistent effect* are more effective than HE against well dug-in positions. Toxic cloud penetration into caves and bunkers can be achieved by near misses. However, toxic chemical area coverage capability will be reduced by the shortage of artillery, the difficulties of supply ammunition, and the nature of the terrain.
- (2) *Chemical attacks for persistent effect* are made to contaminate critical areas such as fortifications, artillery and reserve positions, and command posts. HD can be used to force evacuation of positions flanking the attack or to cause casualties if these positions are occupied despite the contamination.
- (3) *Smoke* is used to isolate enemy fortified positions from observed fire support from adjacent positions, to blind enemy observation posts, to screen movements of friendly troops and vehicles over terrain exposed to enemy observed fire, and to deceive the enemy.
- (4) *Flame* from portable and vehicle-mounted flamethrowers can be used to assist friendly troops assaulting mountain-type strong points. Terrain may limit the capability to bring portable and mechanized flamethrowers into firing position.

Flame delivered by the Air Force can be used to assist in neutralizing enemy artillery and mortar positions and in the reduction of enemy strong points.

c. In the Defense. In defensive mountain operations, friendly troops attempt to retain heights which dominate by observation and fire, hostile routes of communication, and approaches and critical defiles.

- (1) *Chemical attacks for persistent effect* are made to contaminate debris blocking passes and defiles and so delay enemy troops. Because terrain suitable for artillery and mortar positions is limited, contamination of artillery and mortar positions will hamper enemy fire support. Toxic chemical land mines can be used to contaminate demolitions and avenues of approach to delay hostile forces as they approach the main defensive position.
- (2) *Smoke* is used to screen movements of friendly troops and vehicles over terrain exposed to enemy observed fire. It can be used directly on enemy observation posts, as frontal screens, or as blankets or hazes over friendly troops.
- (3) *Flame* should be used to the maximum against assaulting enemy troops. The principles for use in the defense apply.

109. Combat in Snow and Extreme Cold

Combat in snow and extreme cold is characterized by such problems as the retention of body

warmth in personnel and animals and the preservation of supplies and equipment. Shelter and other installations necessary for the conduct of operations are of critical importance. Concentrations of personnel and materiel are often found in cold areas and present lucrative targets for chemical warfare. Although special preparations, equipment and techniques may be required, chemical agents can be employed effectively to assist friendly forces in offensive and defensive operations. Some toxic agents, such as mustard, present a storage problem in extreme cold because of the high freezing point of the agent. The preparation and storage of thickened fuel also present a logistical problem. When used in deep snow, impact-detonating chemical ammunition buries in the snow and the chemical agent tends to be smothered by the snow. Toxic chemical munitions produce less vapor concentration because of the low temperature and the smothering effect of the snow. On the other hand, low temperature increases the persistency of toxic chemicals in both vapor and liquid form. Reduction in masking efficiency requires an efficient CBR alarm and alert system for the protection of friendly forces. The difficulties of movement and supply reduce the amount of artillery available. More reliance may therefore be placed on air delivery of toxics than on normal operations. See FM 31-71 for additional information on operations in the arctic.

a. *Toxic Chemical Agents.* The principles for the employment of toxic chemicals in the offense and defense apply. Toxics are used primarily

against personnel in fortifications and shelters because of the importance of shelter against extreme cold. Near misses will produce casualty concentrations of toxic vapor within the shelters. Artillery is usually concentrated against individual fortifications rather than against area targets. Toxic chemicals, particularly GB, are preferred over HE and nuclear weapons for use against defensive works and facilities to avoid destruction of facilities that friendly forces intend to occupy and use. GB contaminated clothing and equipment is a serious hazard when introduced into the warmth of shelter. Use of HD is limited during periods of extreme cold because of its freezing point and the protection offered by the thick arctic clothing which prevents liquid mustard from reaching the skin of personnel.

b. Smoke. Smoke is relatively unaffected by low temperatures. The effectiveness of artillery and mortar WP smoke ammunition is markedly reduced because of the smothering effect of the snow. The lack of contrast between smoke and snow covered terrain increases the effectiveness of smoke.

c. Flame. Flame landing on snow will have its incendiary and demoralizing effects diminished. Portable and vehicle-mounted flamethrowers have limited capabilities for movement into firing positions. Emplaced flame expedients have limited value because they are difficult to emplace in frozen ground, and they may be covered by snowfall and the flame effects smothered by snow.

110. Combat at Defiles

Combat at defiles is characterized by troops canalized through a relatively narrow space, with obstacles on either side creating the defile. Space for maneuver is limited, and the presence or absence of obstacles and contamination has an abnormal influence in the success of the operation.

a. In the Offense. In offensive operations against a defile, friendly troops attempt to outflank the position. When the flanks are inaccessible, a penetration may be attempted. Chemical attacks for nonpersistent effect are made in the zone of the penetration against enemy troops defending the defile in force when nuclear weapons would create unacceptable obstacles from contamination or blow-down. Chemical attacks for persistent effect are made against occupied positions and critical terrain to the flanks of the defile and on likely avenues of approach for enemy counterattacks. Smoke is used to blind enemy observation on the high sides creating the defile. Flame from portable and vehicle-mounted flamethrowers may be used to assist friendly troops in assaulting enemy strong points. Fire bombs, delivered by the Air Force, assist in neutralizing the flanking positions and soften positions in the path of the attack.

b. In the Defense. In defensive operations, maximum use is made of demolitions and obstacles in front of and within the defile to delay the hostile advance. HD is used to contaminate demolitions and obstacles to delay hostile forces. Chemical land mines and flame expedient mines are integrated

into the barrier system. When the bulk of friendly troops is disposed on the high ground to the flanks which command the defile, chemical attacks for non-persistent effect are made against enemy troops in valleys and similar low terrain, particularly in support of counterattacks when obstacles to maneuver must be avoided. Expected targets of opportunity are assembly areas and reserve positions. Smoke may be used as a haze or screen to deny enemy observation of friendly dispositions and installations.

111. Jungle Operations

Jungle operations are characterized by difficulty in observation, control of troops, maneuver, supporting fires, and logistical support. These difficulties are caused by: restricted visibility, poor lines of communication, and unusual climatic conditions. Climatic conditions have a profound influence in jungle operations. The hot, humid climate, coupled with blazing sun and tropical downpours, must be considered in the employment of toxic agents. Wind speeds and air turbulence are low in jungles, thereby increasing the persistence of toxic clouds. As a result, lower ammunition expenditures are required in jungles. However, detonation of chemical ammunition in treetops tends to balance the ammunition savings. Jungle operations are characterized by combat at extremely close quarters by relatively small bodies of troops. See FM 72-20 for additional information on jungle operations.

a. In the Offense. Chemical attacks for nonper-

sistent effect are made against enemy troops in strong defensive positions which are difficult to destroy with high explosives. Because of the type terrain, jungle operations are necessarily slow and deliberate. Battle positions are generally fixed and maneuver is limited. This permits use of long preparatory fires in which toxic chemicals can be used to assist in the reduction of enemy positions. Days and even weeks may be available for softening up positions. Air delivery of toxic chemicals is effective and, frequently, the only means available for attack of targets. Portable and vehicle-mounted flame throwers are effective in assisting friendly assault teams in their attack of such positions.

b. In the Defense. In defensive jungle operations, friendly forces attempt to block the enemy's routes of approach to his objectives with barriers and obstructions. HD is used to contaminate these barriers and thus hinder the advance of hostile forces. When the approach of enemy forces is canalized by a scarcity of trails, toxic chemical land mines may be integrated into the defensive barrier system. Chemical attacks for nonpersistent and persistent effect are made against attacking enemy troops to assist friendly forces in the defense of the blocking positions. Flame land mines and flame illuminating devices are used to assist in the detection of hostile troops attempting to infiltrate defensive positions during periods of darkness and for casualty effect at all times.

112. Desert Operations

Desert areas vary greatly from rough and rugged

areas to loose sand and high sand dunes or flat hard-surfaced areas. Desert operations are characterized by relatively few obstacles to movement, limited vegetation and water sources, difficulties in maintaining direction and estimating distances, extreme variation in temperature, and utter dependence of movement and operations on supply, particularly water supply. Desert terrain is often very suitable for wide encircling or turning movements by armored or motorized forces. Special equipment and training are required for desert operations. Opportunities for extensive use of chemical agents are generally limited. Toxic chemicals present storage problems because of the extremes in temperature between daytime and nighttime. Extreme lapse conditions during the daytime dissipate toxic clouds and smoke quickly and cause high ammunition expenditures. Use of HD for area contamination is limited because of high ammunition requirements and rapid dissipation of agent. Effective use of toxic agents is generally limited to night and when inversion conditions exist. Large-area smoke screening is of considerable importance because of the normal lack of adequate natural cover and concealment. See FM 31-25 for information on desert operations.

113. Guerilla Operations

Guerilla operations are characterized by small semi-independent friendly forces operating against a greatly superior enemy in any type of terrain from mountains to jungles for the purpose of harassing or delaying larger enemy forces. Special

arms, equipment, and methods of operations are frequently necessary. The tactics employed—small units striking quick surprise blows against enemy units, convoys, or supply trains and avoiding large-scale operations—may favor the employment of chemical agents to support friendly partisan operations. Supply, storage, and transportation are problems associated with the use of toxics in guerilla operations. These logistical difficulties indicate that the use of toxics by guerillas may depend on stocks captured from the enemy and their employment near the point of capture. Incendiary and WP grenades have extensive application in guerilla operation, primarily for the destruction of materiel during raid type operations. See FM 31-21 for information on guerilla operations.

114. Amphibious Operations

Joint amphibious operations present many technical and tactical problems which require special organization, equipment, and a variety of methods of operation. Chemical agents employed against selected targets can assist in prelanding operations designed to facilitate the assault landing. Plans for the employment of chemical agents to support an amphibious landing are developed concurrently and integrated with the overall fire support plan, including nuclear attack. Toxic chemical agents may be used in preparatory air attacks on selected targets. By casualty losses over several days or even weeks, the ability of enemy forces to resist the amphibious landing may be weakened. Chemical agents can be employed most effectively to as-

sist friendly forces in the assault landing on a hostile shore (fig. 8) and, when used against enemy beach fortifications immediately preceding the assault landing, can reduce casualties among assaulting troops. The Air Force and the Navy furnish the chemical fire support immediately before and during the assault landing. See FM 60-5 and 60-10 for detail information on amphibious operations.

a. *Chemical Attack for Nonpersistent Effect.* Chemical attacks for nonpersistent effect are made to augment high explosive fire against enemy troops in strong defensive positions which are resistant to high explosives. The decision to employ toxic chemicals against enemy beach defenses must be based on the latest combat intelligence, including meteorological forecasts. An onshore or flanking

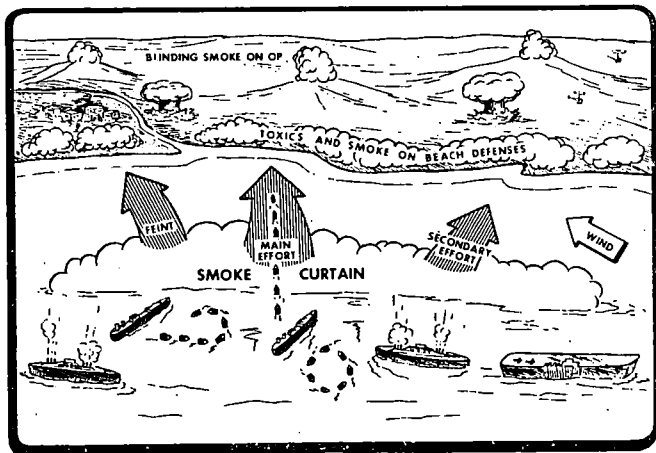


Figure 8. Chemical agents used in support of an amphibious landing.

wind is desirable to minimize the possibility of toxic agent interfering with friendly troops.

b. Chemical Attack for Persistent Effect. Chemical attacks for persistent effect are made to contaminate demolitions of vital transportation facilities, such as bridges, and thus assist in isolating the beachhead from reinforcement by hostile reserves. Consideration must be given to the road net requirements of friendly forces designated to push inland and establish beachhead defenses.

c. Smoke. Smoke is used to blind enemy observation, to deceive the enemy, and, under the considerations, discussed below, to screen the assault landing force. The decision to employ smoke during the assault landing must be based on the known and estimated situation of the enemy defense, meteorological conditions, state of training of troops, features of terrain and hydrography, and the tactical relationship of opposing forces. It is necessary to prepare a variety of smoke plans in order to provide flexibility. Smoke employment plans are very susceptible to changes in meteorological conditions. A number of alternate smoke plans must be fitted to the coordinated employment of supporting arms and within the plans for the entire operation so that the advantages gained by the use of smoke are not nullified by a loss in effectiveness of the supporting arms and in control of ship-to-shore movements.

- (1) Smoke should be laid in the form of hazes rather than blankets over specific areas and as screens in most cases. When used

in this way, smoke is used to obstruct enemy observation from elevated inland positions. Smoke of such density as is required to establish a smoke blanket normally interferes with the precise control and coordination required for the assault wave. When the wind is onshore, blinding smoke may be laid directly on enemy observation posts.

- (2) The initial smoke should be laid by air. Naval gun fire and rockets maintain the smoke once it is established. A frontal curtain may be set up to deny enemy observation, to deceive the enemy of the landing force intentions and directions of the main attack, and to hamper observed fire on the beach. This curtain should be laid so as to drift clear of the beach by H-hour. Smoke should clear the beach inshore so as not to interfere with ship-to-shore movements.
- (3) A flank smoke curtain may hamper visually aimed enemy enfilade fire and cross-fire along the beach.
- (4) Like any other operation under unfamiliar conditions, operations involving smoke should be rehearsed as realistically as conditions will permit.

d. Flame. Flame may be employed by the Air Force in mass and by assault troops to neutralize strong enemy beach defenses in much the same manner as in the attack of a fortified position.

Arrangements must be made for the rapid resupply of fueled and pressurized portable flamethrowers in the early stages of the landing.

115. Airborne Operations

Airborne operations, like amphibious operations, present many technical and tactical problems which require special organization, equipment, and methods of operation. Plans for the employment of chemical agents to support an airborne operation are developed concurrently and integrated with the overall fire support plan, including nuclear attack. Toxic chemicals, particularly GB, can be used in the objective area prior to the assault and in support of ground operations in the airhead. When used in support of the airborne assault, GB targets should be timed so that vapor hazards have cleared drop zones at the time of the assault. Primary reliance for GB attacks during the initial phase of the operation is on the Air Force. The reduction in caliber and quantity of artillery taken into the airhead limits the employment of GB and HD by ground weapons. Principal use of GB is on selected targets in or adjacent to landing zones where casualty effect is required without the obstacles or destruction of HE and nuclear weapons. HD is normally not used because of its delayed casualty effects and dependence on ground weapons for delivery. See FM 57-30 for further detail on airborne operations.

a. *Smoke*. Smoke is used during airborne operations *only* under restricted conditions. Smoke should not drift across the drop zones or landing

zones during the assault landing, since the resulting confusion would offset to a great extent the value gained by the protection given by the smoke to assault troops. Under special circumstances, parachutists may be protected during their descent by a smoke curtain placed between enemy strong points and the friendly drop zones. Smoke curtains of this type would have to be established by aircraft. If smoke generator equipment and personnel are included among the troops landed in assault aircraft, they may be designated to produce smoke to screen selected portions of the established airhead from direct ground or aerial observation or in deception or diversionary roles.

b. *Flame.* The Air Force may deliver fire bombs in mass on selected targets which could interfere with the airborne assault. Portable flamethrowers may be used by airborne infantry in the assault echelon of the airborne attack when intelligence indicates there are suitable targets in the area.

CHAPTER 7

CAPABILITIES OF BIOLOGICAL AGENTS

116. General

Biological warfare is the military use of living organisms or their toxic products to cause death, disability, or damage to men, animals, or crops. Antipersonnel biological agents have the following characteristics:

a. Difficult To Detect. Biological agents produce no immediate physiological reaction, nor can they be detected by the physical senses.

b. Large Area Coverage. Casualties can be produced with small amounts of biological agent. This characteristic gives biological agents the capability of covering large areas with small munition expenditures.

c. Flexibility. The availability of biological agents that can produce deaths or varying degrees of incapacitation among target personnel permits the commander to select an agent that will produce the desired military effect.

d. Delayed Casualty Effect. The incubation period of biological agents results in a lag period of several days before casualties are produced. This time interval can be coordinated with planned future operations.

117. Effects of Weather

Biological agent cloud travel is affected by meteorological conditions in the same general manner as chemical agent cloud travel is affected. However, certain meteorological conditions affect biological agent cloud travel and employment differently.

a. Wind Speed. Biological agents with a high decay rate can be employed effectively at high wind speeds (10 to 20 miles per hour). At these higher wind speeds, biological agents are exposed to adverse environmental conditions for a shorter time, and greater area coverage can be obtained during the decay period.

b. Sunlight. Exposure to sunlight will increase the decay rate of a biological agent aerosol, thereby reducing its area coverage. For this reason, in addition to the existence of an unfavorable temperature gradient on sunny days, the preferable time for a biological attack is at night.

118. Effects of Terrain

Biological agent cloud travel is affected by terrain characteristics in the same general manner as chemical agent cloud travel is affected. Ground contamination following a biological aerosol attack is not generally considered a hazard to troops traversing or occupying the terrain. A few casualties may be produced by secondary aerosols that are formed by marching men and vehicular traffic or by contact with ground contamination.

119. Concepts of Employment

The effectiveness of a biological attack depends

on a number of factors relating to the agent-munition systems. These factors include storage stability, munition dispersion, aerosol decay rate, time to reach useful casualty limits, and concealment of the attack. These factors also affect the selection of the general method of employment of specific munitions.

a. Methods of Employment. The two general methods of employment of biological agents are—

- (1) *On-target attack.* In this method of attack, the biological agent is released directly on the target area. This method provides the maximum degree of operational control. Since the agent is distributed more or less uniformly over the target area, wind direction and velocity are not critical factors.
- (2) *Off-target attack.* In this method of attack, the biological agent is released at a substantial distance upwind of the target area. The agent, once released, is transported over the target area by the wind. This reliance on wind direction for target coverage requires the release of the agent in such a pattern that a wind direction anywhere within a 45° sector will effectively carry the agent over the target area.

b. Agent Selection. The selection of a biological agent for employment on a specific target will be influenced by the following characteristics:

<i>Target characteristic</i>	<i>Agent recommended</i>
Close to friendly forces	High decay rate
Large area target	Low decay rate
Primarily military target	Lethal
High percentage of friendly civilians.	Incapacitating

c. *Munition Selection.* Biological munitions fall into two categories. One type produces an aerosol in a line, relying on the wind to carry the agent over the target. This type of munition is referred to as a *line source*. The other type of munition is randomly scattered over the target area. This type of munition is referred to as *self dispersing*. The selection of these munitions will be influenced by the following target characteristics:

<i>Target characteristic</i>	<i>Munition recommended</i>
Large area	Self dispersing
Poor CBR discipline and/or alert system.	Self dispersing
Target wind direction unknown.	Self dispersing
Wind direction known (within 45°).	Line source
Off target attack preferred or required.	Line source
Small area	Line source

120. Offensive Employment

Enemy targets in the vicinity of the line of contact will not normally be engaged with biological agents because of the delay in producing casualties. Biological agents may be employed, in support of offensive operations, on relatively deep targets such as army and corps reserves, where a delay in casualty effects will be acceptable.

121. Defensive Employment

The length of time that a unit plans to defend a position will determine the areas where biological agents can be employed. If the unit plans to defend a position for a period of time longer than the incubation period of the agent to be used, targets closer to the line of contact may be engaged. Operations that are characterized by successive delaying positions will present targets in areas up to and including the line of contact. Biological warfare casualties may not be produced in time to affect the defense of each delaying position, but casualties will probably be produced by the time friendly forces initiate offensive operations. Accurate intelligence concerning targets that are dispersed over large areas will be difficult to obtain in this type of operation. Biological agents can effectively engage widely dispersed targets because of the large areas that can be covered with little effort and small munition expenditures.

122. Special Operations

a. *Arctic.* Decay of biological agents is not as rapid in arctic areas as it is in temperate or tropical areas. Area coverage capability is increased and the need for refrigerated storage of the munitions is reduced. Other factors that pertain to chemical warfare such as masking efficiency, cloud behavior, and munition efficiency in arctic areas, apply to biological warfare as well.

b. *Jungle.* Planning for the employment of biological agents in jungle areas must include considerations of prevailing low wind speeds and high

temperatures. These two characteristics of jungle areas reduce area coverage capability and increase biological munition expenditures.

c. Island. Enemy forces that are located on isolated islands are ideal targets for biological agents. The agents must be employed sufficiently in advance of the amphibious landing to allow time for the production of casualties. Troop safety is no problem because of the isolated target. Biological agents should be employed at the start of the preparatory fires to enhance the element of surprise and to obtain maximum casualties at the time of the landing.

123. Troop Safety

The selection of the level of effects that will be permitted among friendly troops is a function of command and may vary according to the tactical situation that exists at the time of employment. Lethal casualties among friendly troops will be unacceptable and the number of incapacitated casualties must be kept low enough to prevent a significant effect on the tactical efficiency or morale of the friendly units in the path of the drifting biological aerosol. If there is any indication that the employment of biological agents can affect friendly forces, the commander may take one or more of the following courses of action to protect friendly forces:

a. Utilize a biological agent-munition combination with a smaller radius of effects.

b. Employ biological agents under less favorable meteorological conditions to reduce area coverage.

c. Protect the exposed friendly forces by requiring them to mask for the time required for passage of the primary aerosol.

d. Withdraw the exposed friendly personnel.

e. Immunize friendly personnel.

CHAPTER 8

CAPABILITIES OF RADIOACTIVE MATERIALS

124. General

Radiological warfare is the employment of agents or weapons to produce residual radioactive contamination as distinguished from the initial effects of a nuclear explosion (blast, thermal, and initial nuclear radiation).

125. Characteristics of Radioactive Materials

Radioactive contamination can result from the dissemination of radiological agents or from radioactive fallout and/or neutron-induced radioactivity from the detonation of a nuclear weapon. These sources of contamination may emit one or more of the three types of nuclear radiation: alpha particles, beta particles, and gamma rays.

a. Radiological Agents. Radiological agents are radioactive isotopes used deliberately to contaminate an area with the intent of producing casualties and/or denying use of the area to enemy personnel. To be effective, a radiological agent must emit gamma radiation which penetrates the body in the same manner as X-ray radiation penetrates.

b. Radioactive Fallout. Radioactive fallout consists of particles of soil and other materials which are contaminated with radioactive substances re-

sulting from a nuclear weapon explosion and have fallen back to the earth. When employed deliberately to deny the enemy use of an area, fallout is considered a radiological contaminating material.

c. Neutron-Induced Gamma Radioactivity. Neutron-induced gamma radioactivity results from the reaction between many common nonradioactive materials (such as sodium, phosphorus, and silver) present in the soil and the neutrons released by a nuclear explosion. It is not feasible to employ a nuclear weapon to deny the enemy use of an area by deliberately producing neutron-induced gamma radioactivity.

126. Methods of Dissemination

There are three basic methods for disseminating radioactive materials.

a. Disseminating Radioactive Materials Without a Nuclear Explosion. Radiological agents can be delivered directly to a target area with no nuclear detonation involved. Potential delivery means include conventional bombs, missile warheads, and artillery projectiles.

b. Disseminating Radioactive Materials From a Nuclear Explosion. A nuclear weapon can be deliberately detonated on or below the surface of a target area so that the resulting fallout will contaminate the area with radioactive materials.

c. Disseminating Radioactive Materials From a Specially Constructed Nuclear Weapon. A specially designed explosive nuclear weapon can be detonated deliberately to produce large amounts of

radioactive materials of a particularly desired half-life. Some substances which are stable in nature become highly radioactive when bombarded by neutrons released in a nuclear explosion.

127. Concepts of Employment

The basic concept of the employment of radioactive materials is to deny to the enemy use of an area without destroying installations and material in the area. This is accomplished by producing casualties or the threat of casualties among personnel who do not leave the area in time.

a. Radioactive materials can be employed to contaminate an area of military interest to limit the activities of personnel remaining or to make evacuation of the area mandatory. Since radiological contamination decays with time, reoccupation of the area by friendly forces should eventually be possible with little rehabilitation required of the installations in the area.

b. Radioactive materials can be used to contaminate a vital enemy installation which has been damaged by other weapons and thereby interfere with its reconstruction and repair. Radioactive materials can be used to disrupt and interfere with normal logistical activities in rear areas. They have application in certain tactical operations, such as in retrograde movements, to interfere with the enemy advance.

APPENDIX I

REFERENCES

AR 115-10	Meteorology, Weather Service
AR 220-58	Organization and Training for CBR Warfare
AR 320-50	Authorized Abbreviations
SR 320-5-1	Dictionary of United States Army Terms
FM 3-8	Chemical Corps Reference Handbook
FM 3-9	Staff Chemical Officer
FM 3-50	Chemical Smoke Generator Battalion and Chemical Smoke Generator Company
FM 6-20	Artillery Tactics and Tech- niques
FM 6-40	Field Artillery Gunnery
FM 19-15	Civil Disturbances
FM 20-32	Employment of Land Mines
FM 21-5	Military Training
FM 21-6	Techniques of Military In- struction
FM 21-30	Military Symbols
FM 21-40	Small Unit Procedures in Atomic, Biological, and Chemical Warfare
FM 21-48	CBR Training Exercises
FM 27-10	The Law of Land Warfare
FM 30-5	Combat Intelligence

FM 30-7	Combat Intelligence; Regiment, Combat Command, and Smaller Units
FM 30-15	Examination of Personnel and Documents
(C) FM 30-16	Technical Intelligence (U)
(C) FM 31-5	Landing Operations on Hostile Shores (U)
FM 31-10	Barriers and Denial Operations
FM 31-21	Guerilla Warfare and Special Forces Operations
FM 31-25	Desert Operations
FM 31-50	Combat in Fortified Areas and Towns
FM 31-60	River-Crossing Operations
FM 31-71	Operations in the Arctic
FM 33-5	Psychological Warfare Operations
FM 57-30	Airborne Operations
FM 60-5	Amphibious Operations; Battalion in Assault Landings
(C) FM 60-10	Amphibious Operations; Regiment in Assault Landings (U)
FM 70-10	Mountain Operations
FM 72-20	Jungle Operations
(S) FM 100-1	Field Service Regulations; Doctrinal Guidance (U)
(O) FM 100-5	Field Service Regulations; Operations
FM 100-15	Field Service Regulations; Larger Units

(O) FM 101-5	Staff Officers' Field Manual; Staff Organization and Procedure
TM 3-200	Capabilities and Employment of Toxic Chemicals
(C) TM 3-200A	Capabilities and Employment of Toxic Chemicals (U)
TM 3-215	Military Chemistry and Chemical Agents
TM 3-216	Military Biology and Biological Warfare Agents
TM 3-220	Decontamination
TM 3-240	Field Behavior of Chemical Agents
TM 3-300	Ground Chemical Munitions
TM 3-366	Flame Thrower and Fire Bomb Fuels
TM 9-1900	Ammunition, General
TM 9-1901	Artillery Ammunition
TM 9-1950	Rockets
Pam 39-1	Atomic Weapons Employment
Pam 39-3	Effects of Nuclear Weapons
Pam 108-1	Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings
Pam 310-1	Index of Administrative Publications
Pam 310-2	Index of Blank Forms
Pam 310-3	Index of Training Publications

Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders
Pam 310-5	Index of Graphic Training Aids and Devices
Pam 310-7	Index of Tables of Organization and Equipment, Tables of Organization, Type Tables of Distribution, and Tables of Allowances
TC 3-1	Ground Flame Field Expedients
TC 3-2	Radiological Surveys

APPENDIX II

TOXIC CHEMICAL LAND MINE AMMUNITION REQUIREMENTS

1. General

The present standard toxic chemical land mine is the rectangular can with handle and threaded filling hole in the top (TM 3-300). There are others under development (TM 3-200). Current standard toxic chemical land mines are filled, stored, and issued at chemical depots. Any troop unit which can lay HE mines can also lay chemical mines. Normally, Engineer troops will lay, record, and clear composite ME chemical minefields. Chemical troops may lay and statically detonate chemical mines used to contaminate demolitions, such as bridge approaches. Capabilities of troops to lay mines vary widely because of the variation in the nature of the terrain, the tactical situation, and the training and experience of the troops involved. Capabilities of troops to emplace toxic chemical mines about 4 inches below the surface of the earth approximate those for antitank mines.

2. HD Liquid Contact Hazard

When it is desired to produce an effective liquid contact hazard in a minefield, about 480 pounds of HD per hectare (100-meter square) should be dispersed over the target area. Since the 1-gallon toxic chemical land mine has an agent capacity of

about 10 pounds of HD, a minimum of 48 or in round figures 50 mines would be required per hectare. The number of chemical mines required per hectare varies with the agent capacity of the specific mine used and the percent of agent actually dispersed over the target area as a liquid. About 70 percent of the 1-gallon toxic chemical land mine is actually dispersed over the target area as a liquid, and the remainder is dispersed as a vapor. In a composite HE-chemical minefield, the substitution of a contact-activated chemical mine for an HE mine in every fourth cluster will produce an effective pattern.

APPENDIX III

CHEMICAL SMOKE AMMUNITION REQUIREMENTS

1. General

Detailed smoke ammunition requirements tables have been determined for various weapons under a variety of weather and terrain conditions. The ammunition requirements tables for artillery weapons and the spacing guides for mechanical smoke generators in this appendix are useful as a *guide only*. Expenditures needed in actual smoke operations vary considerably with each specific mission. The amount of smoke ammunition and the spacing of the smoke generators required to maintain the smokescreen must be determined by observation rather than by the figures given in any table. Trained observers are necessary to adjust a large-scale smokescreen to the target, to alter the smokescreen to fit changing conditions, to keep the screen free of holes and gaps, and to increase or decrease the expenditure of smoke ammunition when necessary.

2. Smoke Ammunition

Smoke ammunition may be used to establish and maintain a smoke curtain in enemy held terrain and to blind enemy personnel and cause casualties among them. It takes approximately twice as many rounds of smoke ammunition per minute per 500-

meter front to produce a blinding effect as it does to maintain a smoke curtain. The smoke ammunition expenditure tables V through VII give the approximate number of impacts per minute required to maintain a 500-meter smoke curtain. Under normal conditions, 3 minutes are required to adjust fire on the target and 1 minute is required to establish the smoke curtain. A smoke curtain is established by volley firing twice the amount of ammunition during the first minute as is required to maintain the smoke curtain per minute.

3. Smoke Generators

Smoke generators are used to establish and maintain smoke screens in a friendly territory. The spacing guides for mechanical and thermal smoke generators give the approximate spacings between generators for establishing the initial smokescreen (tables III and IV). These spacings are useful as a guide only to initiate an operation; they must be checked and adjusted by observation. See FM 3-50 for details of operations.

a. Mechanical Smoke Generators. Mechanical smoke generators include the M2 and M3 series and other similar large-volume smoke producing devices.

b. Thermal Smoke Generators. Thermal smoke generators include the statically emplaced burning-type smoke producing device such as "smoke pots."

Table III. Spacing Guide for Mechanical Smoke Generators

Type of terrain	Generator spacing (in meters) at wind speed of 1 $\pm$ 3					
	1-8 mph ⁴		9-15 mph		16-20 mph	
	M2-series	M3-series	M2-series	M3-series	M2-series	M3-series

UNDER LAPSE CONDITIONS ⁵

OVER WATER	54	36	54	27	36	18
OPEN TERRAIN	81	45	54	36	36	27
WOODS	108	63	81	54	54	45

UNDER INVERSION AND NEUTRAL CONDITIONS ⁵

OVER WATER	54	45	54	36	36	27
OPEN TERRAIN	108	54	81	45	54	36
WOODS	108	72	81	63	54	54

¹ Spacings given are for a line of generators normal (perpendicular) to the wind direction.

² The distance between the near edge of the target and the smoke generator line should be at least nine times the spacing between generators.

³ Spacings given are for producing smoke blankets. For establishing smoke hazes, spacings twice those indicated in the table can be used, and generators should be placed farther from the target. To protect against aerial photographic reconnaissance from directly overhead, reduce the spacings by about one-third and place the generators closer to the target.

⁴ When wind speed is very low, water-based generators may have to be worked back and forth along the line.

⁵ See paragraph 43 for an explanation of temperature gradients.

Table IV. Spacing Guide for Smoke Pots

Type of terrain	Smoke pot spacing (in meters) at wind speed of 1 2 3											
	1-8 mph				9-15 mph				16-20 mph			
	AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots		AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots		AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots	
UNDER LAPSE CONDITIONS 5												
OVER		23				18				14		
WATER												
OPEN		27				18				14		
TERRAIN												
WOODS		32				27				18		

See footnotes on p. 133.

Table IV. Spacing Guide for Smoke Pots—Continued

Type of terrain	Smoke pot spacing (in meters) at wind speed of 1 2 3								
	1-8 mph			9-15 mph			16-20 mph		
	AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots	AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots	AN-M7 SGF2 float- ing smoke pots	M4A2 HC float- ing smoke pots 4	M5 HC smoke pots
UNDER INVERSION AND NEUTRAL CONDITIONS 5									
OVER WATER		27			18			14	
OPEN TERRAIN		27			18			14	
WOODS		36			27			18	

¹ Spacings given are for a line of smoke pots normal (perpendicular) to the wind direction.

² The distance between the near edge of the target and the smoke pots should be at least nine times the spacing between smoke pots.

³ Spacings given are for producing smoke blankets. For establishing smoke hazes, spacings twice those indicated in the table can be used, and smoke pots should be placed farther from the target. To protect against aerial photographic reconnaissance from directly overhead, reduce the spacings by from one-third to one-half and place the smoke pots closer to the target.

⁴ Limited standard.

⁵ See paragraph 43 for an explanation of temperature gradient.

4. Unit Capabilities

Unit capabilities to establish and maintain a smoke curtain or a smoke screen vary widely with meteorological conditions.

a. In Enemy Terrain. The size of an area over which a unit is capable of establishing and maintaining a smoke curtain can be determined by two factors: the unit capability to deliver ammunition to target (rate of fire) and the ammunition requirements per 500-meter front (tables V through VII). A heavy mortar company of twelve 4.2-inch mortars can effectively screen an average front of 2,200 meters; under very favorable conditions it can effectively screen three times its average front; under unfavorable conditions it may be able to screen only one-eighth its average front.

b. In Friendly Terrain. The size of the area over which a unit can establish and maintain a smoke screen can be estimated as follows. Refer to table III for mechanical smoke generators and to table IV for thermal smoke generators (smoke pots), and determine the length of the smoke line that the unit is capable of establishing and maintaining under the predicted meteorological conditions. Refer the proposed smoke line to a map of

the area and, noting the direction of the prevailing wind, the size of the area which the unit is capable of covering with a smoke screen can be estimated. See FM 3-50 for details of establishing a ring of smoke generators around the vital area to provide smoke coverage in winds coming from any direction.

- (1) *The mechanical smoke generator company* (48 mechanical smoke generators) can screen an optimum area of about 1 to 2½ miles in width and from 1 to 4 miles in depth.
- (2) *Any troop unit* operating 100 smoke pot installations can screen an optimum area of about 1,900 meters in width and from 450 to 700 meters in depth.

5. Use of Tables

Smoke ammunition expenditure tables V through VII have been calculated on the basis of meters and hectares (an area equal to 100-meter square). To convert meters to yards, multiply by 1.1. To convert hectares to 100-yard squares, multiply by 1.2. Data in the ammunition expenditure tables may be considered optimum for the stated conditions. The tables indicate the number of rounds which must impact in the target area; no allowance has been made for extra shell which, because of dispersion characteristics of the weapon, are needed to insure that the required number fall on the target. Any margin needed for this purpose is the responsibility of the commander of the firing unit since dispersion varies with each type weapon and increases with range.

**Table V. Smoke Ammunition Requirements for
105-mm Howitzers**

SMOKE CURTAIN

Number of rounds per minute required
to maintain a 500-meter smoke curtain ¹

WIND DIRECTION

Following (6 o'clock)	Head (12 o'clock)	Flank (3 or 9 o'clock)	Quartering
22	22	8	17

BLINDING SMOKE EFFECT

Number of rounds per minute required
to maintain blinding smoke effect on a 500-meter front

50	39	8	33
----	----	---	----

SMOKE CURTAIN USING BASE EJECTION, SHELL²

Maximum meters between points of shell impact (parallel to front)		Rate of fire per point of impact (rounds per minute)		
WIND DIRECTION		WIND SPEED		
6 and 12 o'clock	3 and 9 o'clock	3 mph	10 mph	15 mph
27	360	1.0	1.5	2.0

¹ To establish smoke curtain, employ volley firing, using 2-minute ammunition requirement. Rounds are equally spaced on front to be curtained.

² Establish the initial curtain by firing two rounds per point of impact as quickly as possible, and maintain the curtain thereafter at the rate indicated.

Table VI. Smoke Ammunition Requirements For 4.2-Inch Mortars

A. SMOKE CURTAIN

Number of rounds per minute required to maintain a 500-meter smoke curtain in flank winds 1 2 3

Relative humidity (percent)	Temperature gradient ⁴	WP-filled							FS-filled						
		Wind speed (mph)							Wind speed (mph)						
		2	5	10	15	20	25	30	2	5	10	15	20	25	30
30	STRONG LAPSE (LESS THAN MINUS 4.0° F.)	22	22	20					13	17	26				
	LAPSE	13	13	11	11	13			9	9	13	20	22		
	NEUTRAL	9	9	7	7	9	9	11	6	6	9	11	13	17	22
	INVERSION	6	6	4					3	3	6				
60	STRONG LAPSE (LESS THAN MINUS 4.0° F.)	17	17	13					11	11	20				
	LAPSE	9	9	7	9	9			7	7	11	13	17		

90	NEUTRAL	6	6	4	4	6	7	9	4	4	7	9	11	13	17
	INVERSION	3	3	3					3	3	3				
	STRONG LAPSE (LESS THAN MINUS 4.0° F.)	11	11	11					7	9	13				
	LAPSE	7	7	6	6	7			4	4	7	9	11		
	NEUTRAL	4	4	3	3	4	6	6	3	3	4	7	9	9	11
	INVERSION	3	3	3					3	3	3				

B. BLINDING SMOKE EFFECT

The number of rounds per minute required to maintain blinding smoke effect on a 500-meter front is obtained by doubling the values in A above. Use WP-filled shell for blinding and casualty effect.

¹ To establish smoke curtain, employ volley fire, using 2-minute ammunition requirement (but not less than 10 rounds for WP and 15 rounds for FS). Rounds are equally spaced on the front to be curtained.

² For quartering winds, multiply table values by 2; for head (12 o'clock) winds, by 2; for following (6 o'clock) winds, by 2½. Values for quartering and following winds are based on curtain impact line of 500 meters in advance of enemy line. If curtain impact line is closer than 500 meters, ammunition requirements will be considerably greater. CONTROLLED FIRE BY OBSERVERS IS NECESSARY AT ALL TIMES.

³ Table quantities are for shell impacted on land. For water impacts, multiply table values for WP by 1.4; for FS, by 1.6.

⁴ See paragraph 43 for an explanation of temperature gradients.

Table VII. Smoke Ammunition Requirements for 155-mm Howitzers and Guns

SMOKE CURTAIN				
Number of rounds per minute required to maintain a 500-meter smoke curtain ¹				
WIND DIRECTION				
Following (6 o'clock)	Head (12 o'clock)	Flank (3 or 9 o'clock)	Quartering	
7	7	3	6	
BLINDING SMOKE EFFECT				
Number of rounds per minute required to maintain blinding smoke effect on a 500-meter front				
17	11	3	11	
SMOKE CURTAIN USING BASE EJECTION SHELL ²				
Maximum meters between points of shell impact (parallel to front)		Rate of fire per point of impact (rounds per minute)		
WIND DIRECTION		WIND SPEED		
6 and 12 o'clock	3 and 9 o'clock	3 mph	10 mph	15 mph
27	360	0.6	0.9	1.2

¹ To establish smoke curtain, employ volley firing, using 2-minute ammunition requirement. Rounds are equally spaced on front to be curtained.

² Establish the initial curtain by firing two rounds per point of impact as quickly as possible, and maintain the curtain thereafter at the rate indicated.

APPENDIX IV

CONVERSION FACTORS

Table VIII gives conversion factors, some of which were used in computation of tables in this manual and are useful for quick reference.

Table VIII. Conversion Factors

1 meter	39.4 inches
1 meter	1.1 yard
1 kilometer	0.6 mile
1 mile	1.6 kilometers
1 square yard	0.8 square meter
1 hectare	10,000 square meters
1 hectare	11,960 square yards
1 square mile	247.7 hectares
1 milligram	1/1,000 of 1 gram
1 ounce	28.35 grams
1 pound	453.6 grams
1 round per 100-yard square	1.2 rounds per hectare
1 round per yard	1.1 rounds per meter
Degrees Fahrenheit	9/5° C. + 32°
Degrees centigrade	5/9 (° F. — 32°)

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By Order of *Wilber M. Brucker*, Secretary of the
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NG: State Ag (6); units—same as Active Army except allowance is one copy to each unit.

USAR: Same as Active Army except allowance is one copy to each unit.

For explanation of abbreviations used, see AR 320-50.

FIELD MANUAL

TACTICS AND TECHNIQUES OF CHEMICAL,
BIOLOGICAL, AND RADIOLOGICAL (CBR)
WARFARE

FM 3-5

CHANGES No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., 17 May 1960

FM 3-5, 5 November 1958, is changed as follows:
Throughout the manual, change the terms "nerve gas" and "blister gas" to read nerve agent and blister agent.

2. Scope

This manual describes * * * the field commander.

* * * *

c. Biological and Radiological Warfare. This manual also * * * or friendly forces. Biological agent munition expenditure tables are given in TC 3-7(S).

* * * *

4. General Policy for the Employment of Toxic Agents

Authority to initiate * * * the local commander. The local commander will receive guidance relating to the employment of toxics through command channels. There are no * * * and adjacent units.

21.1. Incapacitating Agents, Non-Lethal
(Added)

Incapacitating agents are chemical agents which produce physiological or mental effects that prevent

exposed personnel from performing their military duties for a militarily significant period of time and from which there is complete recovery.

24. Median Lethal Dosage

The median lethal * * * of vapor dosage. For example, the median lethal dosage of GB is estimated to be 70 mg-min/m³.

33. Toxic Chemical Agents

(Superseded)

Toxic chemical agents produce lethal or injurious effects when in contact with the skin, when inhaled, or when ingested by personnel. The standard toxic chemical agents are—

a. GB (Nerve Agent). GB is a quick-acting chemical agent which in liquid or vapor form produces casualties by paralyzing respiratory muscles of exposed personnel. Inhalation of GB vapors can cause casualties within minutes. Both liquid GB and high concentrations of the agent vapor can cause casualties quickly upon contact with the skin.

b. HD (Blister Agent). HD is a delayed-acting chemical agent which in liquid or vapor form produces casualties among exposed personnel by blistering action on the eyes, skin, or respiratory system. Initial symptoms of HD poisoning usually appear in 4 to 6 hours.

36. Training and Riot Control Agents

(Superseded)

Chemical training and riot control agents are those agents which produce irritating or disabling physiological effects when in contact with the eyes

and skin or when inhaled by personnel. See FM's 19-15 and 21-48 for details of employment.

a. *Cl*. Chlorine (Cl) is a quick-acting, powerful irritant of the respiratory tract. It is a true gas and is used in gas chambers for training troops.

b. *CN*. CN is a solid which when dispersed as an aerosol by burning causes eye and skin irritations and an intense flow of tears. CNC is a solution of CN dissolved in chloroform. When dispersed as an aerosol, CNC produces effects similar to those produced by CN.

c. *DM*. DM is a solid which when dispersed as an aerosol causes violent sneezing, nausea, and vomiting. DM is normally mixed with CN in riot control munitions to obtain combined effects of CN and DM.

d. *CS*. CS is a quick-acting, powerful irritant of the eyes, nose, and throat that may also, in high concentrations, cause vomiting. It is a solid which can be disseminated from burning- and bursting-type grenades and by bulk disseminating means.

52. Selectivity

The commander can * * * on the target. The effects range from harassment of personnel or interdiction of an area, to *lethal* action. For example, HD is effective in restricting the use of terrain or materiel. GB can produce casualties without causing damage to installations and facilities. These installations or facilities can then be occupied or utilized by friendly forces with a minimum of time and effort expended to bring them into use.

70. Safe Distance Data

Toxic chemicals present * * * to be exposed.

a. *G.B.* See TM 3-200 * * * from GB vapor. The commander may indicate the degree of hazard which he will accept for friendly troops downwind of the target area.

(1) Negligible hazard—less than 5 mg-min/m³.

(2) Acceptable hazard—5 mg-min/m³.

(3) Emergency hazard—between 6 and 10 mg-min/m³.

* * * * *

77. Employment of Smoke in Friendly Areas

Smoke may be * * * in the attack.

a. *Attenuation Effects.* (Rescinded.)

* * * * *

78. General

Flame is used * * * delivered fire bombs.

a. *Flame Weapons.* Ground flame weapons * * * and airborne units. Integral-type mechanized flame weapons may be organic to combat units.

* * * * *

c. *Incendiary Munitions.* Incendiaries are used * * * equipment and materiel. Air-delivered incendiary munitions can be effectively employed to reduce an enemy's war-making capability by destruction of factories and other vital facilities. Equipment and materiel destruction incendiaries can be positioned by troops.

79. Types and Characteristics

* * * * *

b. *Incendiaries.* Incendiaries produce an intensive localized heat. They are used to start fires and

to destroy nonflammable materiel, such as abandoned artillery weapons.

101. Toxic Chemical Minefields and Barriers

Toxic chemical land * * * in vegetated areas.

a. Composite Minefield. The E5 chemical mine is designed for individual detonation by the enemy. The composite minefield * * * present lucrative targets. E5 chemical mines are integrated into the standard minefield in a nonuniform pattern. Uniform contamination of * * * every fourth cluster.

b. Toxic Chemical Minefields. The M1 chemical * * * into the area. The authority to detonate toxic chemical mines must be delegated to the lowest echelon responsible for defending the mined area.

* * * * *

128. Troop Safety

(Added)

The problems associated with protecting friendly troops when employing radiological warfare are different from the situations encountered when employing biological or chemical agents.

a. Individual Protection. The primary hazard associated with radioactive contamination is gamma radiation. Because of the penetrating nature of gamma radiation, complete protection is difficult to achieve while crossing a contaminated area. The hazard can be minimized by utilizing armored carriers or vehicles following preselected routes which permit a speedy and uninterrupted crossing.

b. Decay and Exposure Considerations. The decay of radioactive material can be predicted in

accordance with physical laws. However, the average rate of decay will vary with the source of the radiation. The rate of decay of gross fission products in normal radioactive fallout can be calculated by using the tables, graphs, or nomograms contained in FM 101-31(S), DA Pam 39-1, and TC 101-1. Total dose charts and nomograms contained in these publications can be used to predict the total exposure dose received when operating in a contaminated area.

c. Location of Contaminated Area. The vagaries of the wind, along with other variables, prevent an accurate prediction of the location and dose rate of the radioactivity which will result from fallout. However, it is possible to predict a general area within which there is a high assurance that all militarily significant contamination will be contained. This prediction method is described in DA Pam 39-1 and TC 101-1. Nevertheless, only through monitoring and survey is it possible to definitely locate the area of contamination.

d. Command Responsibility. Protection is obtained by limiting time of exposure, by employing some sort of shielding, by avoiding contaminated areas, or by some combination of these measures. It is a function of command to decide on that course of action, consistent with tactical requirements, which will accomplish the mission and at the same time result in the least exposure.

APPENDIX I

REFERENCES

- (Added) FM 101-31 Nuclear Weapons Employment (U)
- (Added) TC 3-7 Capabilities and Employment of Biological Agents (U)
- (Added) TC 101-1 Prediction of Fallout and Radiological Monitoring and Survey.

APPENDIX II

CHEMICAL LAND MINEFIELD AMMUNITION REQUIREMENTS

1. General

The present standard * * * lay chemical mines. Normally, Engineer troops will lay, record, and clear composite HE-chemical minefields. Chemical troops may * * * for antitank mines.

2. Liquid Contact Hazard

When it is * * * the target area. Since the M1 1-gallon toxic chemical land mine has an agent capacity of about 10 pounds of HD, a minimum of 48 or in round figures 50 mines would be required per hectare. The number of * * * as a liquid. About 70 percent of the agent of the M1 toxic chemical land mine is actually dispersed over the target area as a liquid, and the remainder is dispersed as a vapor. In a composite * * * an effective pattern.

[AG 300.7 (2 Feb 60)].

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For explanation of abbreviations used, see AR 320-50.



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